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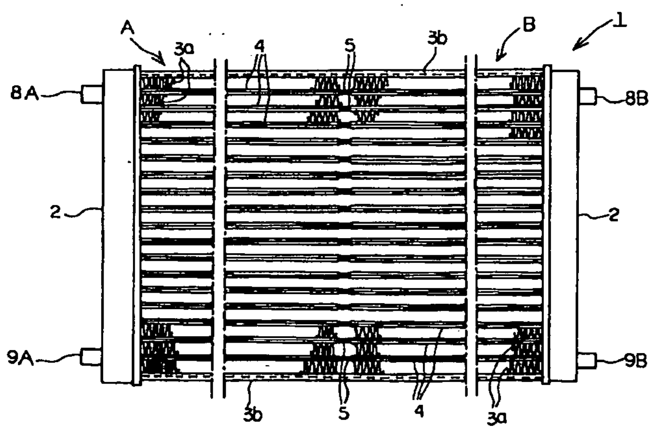
(54) HEAT EXCHANGER

(57) A heat exchanger 1 including a pair of tanks, 2, 2, and a plurality of tubes 4, 4 and fins 3a, 3a disposed between tanks 2, 2, wherein each tube 4 includes a sealed section 5 at the midpoint to divide a passage into two passages 6, 7. Thus, one passage on one side is formed in a U-shape and connected to the tank 2 on one side, and the other passage on the other side is formed in the U-shape and connected to the tank 2 on the other side, thereby the U-shaped passage and the tank on one side form a first heat exchanger A having a single tank structure, and the other U-shaped passage and the other tank on the other side form a second heat exchanger having the single tank structure. A heat insulation region 11 without a fin is formed between the first and second heat exchangers. The first and second heat exchangers are integrally brazed to form a heat exchanger, wherein each tube 4 is formed by folding a single plate into halves or joining two plates made of an aluminum material or aluminum alloy with both faces clad with a brazing material, and the sealed section 5 is formed to divide the passage into two passages in a longitudinal direction of the tube.

FIG.1



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Description

TECHNICAL FIELD

The invention relates to a heat exchanger formed into one body by combining two heat exchangers having different applications and arranging them horizontally or vertically or by disposing them at upstream and downstream of a flowing direction of air.

BACKGROUND ART

Generally known heat exchangers for automobiles and household electrical appliances include a parallel flow type heat exchanger and a single tank type heat exchanger.

Generally, the parallel flow type heat exchanger has a plurality of tubes and fins stacked alternately, both ends of the stacked tubes being inserted and bonded in insertion holes formed on tanks disposed vertically or horizontally. And, partition plates for dividing the tanks in a longitudinal direction are disposed at required portions of the tanks to divide them in the longitudinal direction, thereby meandering a heat exchange medium a plurality of times to flow between inlet and outlet joints formed on the tanks. In other words, this heat exchanger has a structure that the heat exchange medium supplied through the inlet joint is flown while meandering a plurality of times through the tubes between the tanks to make heat exchange with the outside while flowing through the tubes and discharged from the outlet joint.

And, the single tank type heat exchanger has a structure that tubes having a U-shaped passage are connected to a single tank.

Conventional known heat exchangers have two heat exchangers having different applications and which are combined horizontally or vertically. And, it is proposed by Japanese Utility Model Publication No. Sho 59-16692, Japanese Utility Model Laid-Open Publication No. Sho 61-115862 and Japanese Utility Model Laid-Open Publication No. Hei 2-36772 that such a heat exchanger may have tubes and fins disposed between a pair of tanks and a partition plate at the midpoint between the pair of tanks, thereby substantially having separate heat exchangers though it is a single heat exchanger in view of the structure.

And, Japanese Utility Model Publication No. Hei 6-45157 proposes that a third tank having two tank segments is disposed between right and left tanks, and tubes and fins are disposed between the respective tank segments of the third tank and the right and left tanks, thereby having separate heat exchangers on right and let sides practically.

Japanese Utility Model Laid-Open Publication No. Hei 2-54076 proposes a heat exchanger having a first heat exchanger and a second heat exchanger formed into one body which is configured by stacking flat plate fins, connecting to communicate a plurality of tubes with the plate fins, connecting ends of the tubes to an end plate configuring a tank, and assembling a tank plate to the end plate, wherein the end plate and the tank plate are separately formed or the tank plate is separately formed.

By forming the two heat exchangers having different functions into one body as described above, the number of components is decreased, the working steps is decreased, and the cost can be reduced. And, when the heat exchangers having different functions are formed into one body, there is an advantage that a heat exchange space can be decreased.

As described in Japanese Utility Model Publication No. Sho 59-16692 and Japanese Utility Model Laid-Open Publication No. Hei 2-36772, however, the conventional heat exchanger formed of a plurality of heat exchangers, which has the partition plate at the midpoint .of the pair of tanks to have two heat exchange regions which are divided by the partition plate, has disadvantages that heat is conducted readily because the tank has one body and heat is conducted through the partition plate fitted to the tanks.

The heat exchanger described in Japanese Utility Model Publication No. Hei 6-45157 has a hollow portion between the two tank segments of the third tank disposed at the center to prevent the heat conduction. But, since the third tank is disposed between the right and left tanks, there is a disadvantage that the heat exchange space for disposing the tubes is decreased, and the heat exchange efficiency is lowered.

And, the heat exchanger, which has heat exchangers with different functions formed into one body, has different heat exchange temperatures and different heat radiation rates owing to the functions of the respective heat exchangers. For example, where a radiator and a condenser are compared under certain conditions, the radiator performs heat exchange at higher temperatures. Therefore, a heat exchanger having a radiator and a condenser formed into one body has a disadvantage that heat is conducted to the condenser because the radiator has a higher heat exchange temperature, thereby preventing the heat radiation of the condenser and lowering the heat exchange rate of the condenser.

As described above, forming heat exchangers having different functions into one body has drawbacks that the respective heat exchangers have different optimum temperatures, heat is conducted between the respective heat exchangers through the integrally formed fins, tubes and tanks, and the respective heat exchangers formed into one body can not make heat exchange at the optimum temperature.

It is an object of the invention to provide a heat exchanger formed of separate heat exchangers having different applications assembled into one body in which heat conduction between the respective heat exchangers is prevented.

And, the heat exchanger having two heat exchang-

ers formed into one body has variable required performance such as a pressure applied to the tube itself and corrosion resistance required for the tube, depending on the functions of the respective heat exchangers. For example, when a first heat exchanger is a radiator, a second heat exchanger is a condenser, and they are integrally formed into a heat exchanger, the radiator requires a high corrosion resistance on the inner and outer surfaces of the tubes. On the other hand, the condenser is required to have a high-pressure resistance because it condenses a high temperature and high pressure heat exchange medium. And, the inner surface of the tubes of the condenser does not have a corrosion problem because it is in contact with the flowing heat exchange medium, but the outer surface of the tubes is required to have a high corrosion resistance because it is exposed to high temperature and humid surroundings.

Conventionally, generally used tubes are known to be formed of, for example, an improved material of JIS (Japanese Industrial Standard) A 1050 or A 1100 (99.0 wt% of Al) with Cu added by extrusion molding. The fins are also known to be formed of a brazing material, an improved material of JIS A 4343 or JIS A 4045 (Al-Si based) with Zn added and clad with it, and A 3003 (Al-Mn based) with Zn added.

Where such tubes and fins are used for the first and second heat exchangers (radiator and condenser), the tubes have a good pressure resistance in view of the properties of the extruded material, and when the fins and the tubes are combined, the surface of the tubes has a high potential and the fins are determined as sacrificial anode, so that fins are corroded with priority to prevent the tubes from being corroded. Thus, the outer face of the tubes has good corrosion resistance, satisfying the required performance of the condenser as the second heat exchanger. But, the tubes have poor corrosion resistance on the inner surface and cannot satisfy the required performance of the radiator as the first heat exchanger.

Since the tubes and fins are brazed together integrally, it is necessary to use a brazing sheet clad with a brazing material to form the fins, but since a die used for forming the fins is heavily abraded due to a fin material clad with the brazing material, the maintenance cost is increased, the material cost is increased, and the production cost is increased as a result.

To solve such problems, tubes satisfying the required performance of the respective heat exchangers may be formed separately. For example, the tubes of the first heat exchanger are electric-welded tubes which are formed of a three-layered material consisting of JIS A 3003 (Al-Mn based) as a core material, a brazing material of JIS A 4343 or JIS A 4045 (AL-Si based) clad to a layer forming the outer surface of the tubes, and JIS A 7072 (Al-Zn) material clad to a layer forming the inner surface of the tubes, and the tubes of the second heat exchanger are formed of an improved material of JIS A 1050 or A 1100 (99.0 wt% of Al) with Cu added by extrusion molding. The tubes of the first exchanger have the potential of the core material determined high owing to a difference of electric potential between JIS A 3003 material as the core material of the tube and JIS A 7072 (Al-Zn) material, and the corrosion resistance of the inner surface of the tube is improved owing to a sacrificial anode effect of JIS A 7072 material. And the outer face of the tube given an improved corrosion resistance owing to a sacrificial corrosion resistance of the fins, so that the required performance of the first heat exchanger can be satisfied.

But, since it is necessary to form the tubes separately for the first and second heat exchangers, there are problems that the number of components is increased, and the assembling and working processes become difficult. And, the fins in this case also need the use of a fin material clad with a brazing material. And the drawbacks of increasing the maintenance cost and the material cost are not solved.

The fins may be made of a material not clad with a brazing material, while the tubes may be formed of a material clad with a brazing material. For example, in view of the corrosion resistance of the first heat exchanger, the tubes may be formed of a material which is made of JIS A 3003 (Al-Mn based) material as a core material and clad with a brazing material of JIS A 4343 or JIS A 4045 (Al-Si based) material. Since extrusion processing is poor in this case, the tubes cannot be fabricated by extrusion molding, and therefore an electric-welded tube is required to be formed. But, there is a drawback that the electric-welded tube cannot satisfy a pressure resistance that the second heat exchanger (e.g., a condenser) is required to have.

Accordingly, the present invention aims to provide a heat exchanger having first and second heat exchangers formed into one body, which can be produced at a reduced production cost by forming tubes satisfying the required performance of the respective heat exchangers into one body.

SUMMARY OF THE INVENTION

A first aspect of the invention relates to a heat exchanger which comprises a pair of tanks and a plurality of tubes and fins disposed between the tanks, wherein the tubes have a sealed section at the midpoint to divide a passage into two to form a passage on one side connected to a tank on one side and other passage on the other side connected to a tank on the other side so that each passage has a U-shape, and the tank on one side and the U-shaped passages on one side of the tubes configure a first heat exchanger having a single tank structure, and the tank on the other side and the U-shaped passages on the other side of the tubes configure a second heat exchanger having a single tank structure.

By configuring as described above, the heat

exchanger has a pair of tanks and a plurality of tubes and fins disposed between the tanks. This heat exchanger is a combination of the heat exchangers respectively having substantially a single tank structure, nevertheless the plurality of tubes and fins are alternately stacked and disposed between the pair of tanks. Besides, the tubes are integrally formed between the pair of tanks and both ends of the tubes and fins are supported by the pair of tanks to enhance the rigidity of the heat exchanger. In other words, even the single tank structure can have the features of the parallel flow type.

And, since both the first and second heat exchangers have a single tank structure and have an advantage inherent in the single tank structure that the tanks are decreased to half as compared with the parallel flow type heat exchanger, a space to be used for the tanks can be used for the heat exchange. Therefore, there are advantages that the heat exchange efficiency is improved, the number of components is decreased, and the cost can be reduced.

Further, the first and second heat exchangers are configured in a connected form, and their rigidity is improved as described above. On the other hand, since they are adjacent to each other, heat is conducted between them and performance may be degraded. In this connection, however, a sealed section is formed at the midpoint of the tubes to prevent the heat exchange medium from flowing between the first and second heat exchangers and to lower the heat conduction between them as low as possible, thereby preventing the performance from being degraded.

In the heat exchanger according to the first aspect of the invention, the tubes are formed of two plates which are joined or a single plate which is folded into halves.

In other words, the invention is applied when the tube is formed by connecting two plates formed by pressing or rolling, by folding a single plate formed by pressing or rolling into halves, or by folding a single plate into halves while rolling.

In the heat exchanger according to the first aspect of the invention, the tubes are stacked to be integrally formed with tank segments forming the tanks.

The heat exchanger configured as described above is a so-called laminate type having the tanks configured with the tubes integrally. Thus, the invention can also be applied to the laminate type.

In the heat exchanger according to the first aspect of the invention, the sealed section of the tube has heat-insulating holes.

The sealed section enables to connect the passages of the first and second heat exchangers to integrally form the tubes and to lower the heat conduction between them as low as possible. And, the heat insulating effect can be improved further by forming holes on the sealed section.

In the heat exchanger according to the first aspect of the invention, the sealed section of the tube has a heat-insulating cavity.

Similar to the previous case, the heat insulating effect can be additionally improved by the cavity.

In the heat exchanger according to the first aspect of the invention, the sealed section of the tube has a folded part, the first and second heat exchangers are provided with separate fins, and the ends of the fins are positioned at the folded part of the sealed section.

Since the separate fins are disposed for the first and second heat exchangers, fins having performance suitable to the respective heat exchangers can be prepared separately, thereby satisfying the required performance of the respective heat exchangers. And, since the sealed section has the folded portion, the ends of the fins can be positioned at the folded portion. As a result, the ends of the fins are prevented from extending from the folded part, and the fins are mounted properly.

In the heat exchanger according to the first aspect of the invention, a single fin is disposed along the first heat exchanger and the second heat exchanger respectively, and has a different number of ridges in the first heat exchanger and the second heat exchanger.

Thus, since the single fin is disposed along the first heat exchanger and the second heat exchanger, it is economical because one type of fin is sufficiently used. And, the fin has different number of ridges for the first heat exchanger and the second heat exchanger (a change of fin pitches) so to comply with the required performance of the respective heat exchangers.

In the heat exchanger according to the first aspect of the invention, the tubes and fins are assembled into one body and brazed in an oven.

Thus, basically, the tubes and the fins are assembled into one body and brazed in the oven. In addition to the brazing of the tubes and the fins, any of the tank, the tank segments configuring the tank, the end plate configuring the tank is brazed at the same time.

In the heat exchanger according to the first aspect of the invention, the tubes, fins and tanks are assembled into one body and brazed in the oven.

In this case, the tanks are cylindrical or a split type combined into the tank and brazed together with the tubes and the fins, integrally.

In the heat exchanger according to the first aspect of the invention, the tubes, fins and tank segments stacked to form the tank are assembled into one body and brazed in the oven.

In this case, the above-described laminate type having the tank segments integrally formed with the tubes is brazed into one body.

In the heat exchanger according to the first aspect of the invention, the tubes, the fins and the end plate are assembled into one body and brazed in the oven, and a tank plate is joined to the end plate.

The tank in this case is formed of the end plate and the tank plate. After brazing the tubes, the fins and the end plate, the tank plate is assembled and connected by caulking with a sealing material.

In the heat exchanger according to the first aspect of the invention, a side plate is disposed between the pair of tanks.

And, the side plate improves the strength of the heat exchanger. And, the side plate is preferably brazed at the same time.

A second aspect of the invention relates to a heat exchanger having tubes and fins stacked alternately and the ends of the tubes inserted into tanks, wherein a heat exchanger body formed by stacking the tubes and the fins is divided into a first heat exchanger and a second heat exchanger, and a heat insulation region not having a fin is disposed between the divided first and second heat exchangers.

Thus, when the heat insulation region not having a fin is disposed between the divided first and second heat exchangers, heat conduction between the adjacent heat exchangers can be prevented by the heat insulation region, and this provides the one-body heat exchanger with the performance of the respective heat exchangers prevented from being degraded. And, since the first and second heat exchangers having two different applications are formed into one body, the heat exchange space can be increased to improve the heat exchange rate, and the number of components is decreased, then the cost can be reduced.

In the heat exchanger according to the second aspect of the invention, the first and second heat exchangers are mutually adjacent vertically or horizontally, and a bonding plate is disposed in the heat insulation region to connect the adjacent first and second heat exchangers.

Thus, when the bonding plate is disposed in the heat insulation region to connect the adjacent first and second heat exchangers, the heat insulation region is reinforced, and, then the entire heat exchanger is reinforced. In other words, the heat insulation region may lower the pressure resistance therefor, and there may be a drawback that the heat exchanger is deformed during production. Therefore, the bonding plate is disposed in the heat insulation region formed between the respective heat exchangers to reinforce the heat exchanger, thereby the above-described drawback can be eliminated. And, the bonding plate may be disposed by integrally brazing in the oven in addition to the brazing of the tubes and the fins.

In the heat exchanger according to the second aspect of the invention, a partition is disposed in the tanks to divide the first and second heat exchangers.

By configuring in this way, the partition is disposed between the first and second heat exchangers having the common tank to prevent the heat conduction between the respective heat exchangers, and this provides the one-body heat exchanger with the performance of the respective heat exchangers prevented from being lowered.

In the heat exchanger according to the second aspect of the invention, the partition is formed of at least two partition plates, which form a cavity in the tanks.

Thus, the heat conduction between the first heat exchanger and the second heat exchanger can be prevented by the heat insulation action of the cavity formed in the tank.

In the heat exchanger according to the second aspect of the invention, the cavity has a communication hole to communicate with the outside.

By configuring in this way, the atmosphere air flows through the cavity to improve the heat insulation action of the cavity. And, in case of a bypass leakage due to a poor bonding of the two partition plates, the presence of the cavity makes it easy to find the leak by an airtight test, enabling early finding of a defective product. And, the communication hole may allow the atmosphere air to permeate into the cavity and to accumulate water in the cavity due to environmental changes such as changes of atmospheric pressure and temperatures. Therefore, the communication hole is preferably formed at a lower part of the tank. Thus, water can be discharged from the cavity with ease, and the tank can be prevented from being corroded by water.

In the heat exchanger according to the second aspect of the invention, the first and second heat exchangers are disposed between a pair of tanks, the respective tubes have a sealed section at the midpoint to divide each passage, passages on one side connected to the tank on one side and passages on the other side connected to the tank on the other side are formed to have a U-shape. Thus, a first heat exchanger having a single tank structure is formed of the tank on one side and the U-shaped passages on one side of the tubes, a second heat exchanger having a single tank structure is formed of the tank on the other side and the U-shaped passages on the other side of the tubes, and the heat insulation region is formed on the sealed section for dividing the respective tubes.

By configuring as described above, the heat conduction between the heat exchangers each having the single tank structure and formed into the one-body heat exchanger can be decreased as low as possible by the sealed section and can be prevented by the heat insulation region, so that the performance of the respective heat exchangers can be prevented from being degraded. And, by forming the first and second heat exchangers each having a single tank structure into one body, the heat exchange space is enlarged to improve the heat exchange rate. And, the number of components is decreased, and the cost can be reduced.

In the heat exchanger according to the second aspect of the invention, the first and second heat exchangers each have a single tank structure and are disposed adjacent to each other horizontally or vertically, and the tubes are integrally formed with the tank segments configuring the tank.

The heat exchanger configured as described above is a so-called laminate type having the tank segments integrally formed with the tubes. And, the invention can

also be applied to the laminate type heat exchanger.

According to the second aspect of the invention, the heat exchanger has the plurality of heat exchangers having substantially different applications formed into one body, wherein the heat insulation region not having a fin is formed between the respective heat exchangers to prevent the heat conduction between the heat exchangers. Thus, the heat exchanger having an improved heat exchange rate can be obtained.

A third aspect of the invention relates to a heat exchanger which comprises tubes configuring a first heat exchanger and tubes configuring a second heat exchanger which are disposed downstream and upstream of a flowing direction of air, fins disposed between the tubes, ends of the tubes inserted into respective tanks to form the first and second heat exchangers, and the first and second heat exchangers brazed into one body, wherein the tubes are formed by folding a single plate or joining two plates made of an aluminum material or aluminum alloy with both sides clad, each tube has a sealed section to divide its passage into two in a longitudinal direction of the tube so to form the first heat exchanger by the passages on one side and the second heat exchanger by the passages on the other side, and the fins disposed between the tubes are made of an aluminum material or aluminum alloy not clad.

Thus, when the first and second heat exchangers have the tubes which are formed of the aluminum material or aluminum alloy with both sides clad, the core material has a high electric potential owing to a difference of electric potential between the core material and the brazing material having both sides clad, and the outer and inner surfaces of the tubes can have an improved corrosion resistance owing to a sacrificial anode effect of the brazing material.

Therefore, for example, when the first heat exchanger is required to have a corrosion resistance on the inner and outer surfaces of the tubes, and the second heat exchanger is not highly required to have a corrosion resistance on the inner surface of the tubes, but, it is required to have a corrosion resistance and a pressure resistance on the outer surface of the tubes, these heat exchangers having substantially different applications are formed into one body. Thus, the tubes satisfying the required performance for the respective heat exchangers can be formed integrally. And, since the sealed section is formed in the tubes, the heat conduction between the respective heat exchangers can be decreased as low as possible by the sealed section, the heat conduction between the respective heat exchangers can be prevented, and the heat exchange rate can be improved.

And, since the tubes are clad with a brasing material, the fins can be made of an aluminum material or aluminum alloy not clad with a brazing material, so that the abrasion of the die caused when the fins are made of a material clad with the brazing material can be decreased, the maintenance cost can be reduced, and the material cost can also be reduced, so that the production cost can be reduced.

In the heat exchanger according to the third aspect of the invention, a tube material for the tubes is a three-layered material formed of an aluminum material or aluminum alloy as a core material, and a layer forming the inner face of the tube and a layer forming the outer face of the tube clad with an Al-Si based brazing material, or a four-layered material formed of an aluminum material or aluminum alloy as a core material, an intermediate layer clad with an aluminum material or aluminum alloy having a potential lower than that of the core material, and a layer forming the inner face of the tube and a layer forming the outer face of the tube clad with an Al-Si based brazing material.

Thus, when the tubes are made of the four-layered material having the intermediate layer with a potential lower than that of the core material disposed between the core material and the brazing material, the corrosion resistance of the inner surface of the tubes is improved by a sacrificial corrosion resistance uniform on the surface of the intermediate layer.

And, when the tubes are formed of an aluminum material or aluminum alloy of the three- or four-layered material with both surfaces clad, the pressure resistance of the tubes is improved.

In the heat exchanger according to the third aspect of the invention, the tubes have a plurality of projections formed in the passage on one side or the passages on both sides to protrude inwardly, tips of the projections are mutually contacted or contacted with the flat face.

Thus, when the projections are formed on either or both of the passages of the tubes, the tips of the projections are mutually contacted or the tips of the projections are contacted with the flat surface of the plate to divide the passage into a multiple number, and the heat exchange medium flowing through the passages is made turbulent to improve the heat exchange rate. And, the pressure resistance of the tubes can be improved, so that the projections are formed on either or both of the passages as required to make it possible to satisfy the required performance of the respective heat exchangers. In this case, since the aluminum material or aluminum alloy with both surfaces clad is used, the projections are easily contacted and can be formed as required.

In the heat exchanger according to the third aspect of the invention, the tubes are formed of a single plate which is folded into halves, ends of the plate forming the tubes are overlaid and brazed on a bead portion, a flat portion, the end portion or the passage portion of the tubes.

Conventionally, when the tube is formed by bonding ends of a single plate to have the plate ends protruded outwardly of the tube ends, the tube may have different shapes of cross sections at both sides, and, therefore, it is necessary to form the tube insertion holes of header

tanks to match the shapes of the cross sections of the tube, requiring a dedicated jig or the like. Therefore, there are disadvantages that the production cost becomes high, and the production process becomes complicated.

According to the present invention, by changing the bonding portions at the ends of the plate used to form the tube, which is formed of a single plate by folding it into halves, the tube can have the same shape of cross section at both sides, its assemblability can be improved, the manufacturing fixtures and equipment can be decreased and the manufacturing process can be simplified.

In the heat exchanger according to the third aspect of the invention, the respective tubes have passages on one side connected to the tank on one side and passages on the other side connected to the tank on the other side formed to have a U-shape, then the first heat exchanger having the single tank structure is formed of the tank on one side and the U-shaped passages on one side of the tubes, and the second heat exchanger having the single tank structure is formed of the tank on the other side and the U-shaped passages on the other side of the tubes.

Namely, the invention is also used for a heat exchanger having the tubes in which U-shaped passages are formed. The heat exchanger having this configuration is a single tank type which is formed by connecting the U-shaped passages and the tube ends on the other side to the tank. And the invention can also be applied to this tank single type heat exchanger.

Such a single tank type heat exchanger has advantages that the tank is half of the parallel flow type heat exchanger, an area to contact with air is increased to improve the heat exchange rate, the number of components is decreased, and the cost can be reduced.

In the heat exchanger according to the third aspect of the invention, the tubes have heat insulation holes formed on the sealed section for dividing the passage.

Thus, by forming the sealed section on the tubes, the heat conduction between the first and second heat exchangers can be decreased as low as possible by virtue of the sealed section, and by forming the heat insulation holes on the sealed section, the heat conduction can be further prevented. Therefore, there is an advantage that the respective heat exchangers have an improved heat exchange rate.

Besides, in the heat exchanger according to the third aspect of the invention, the tubes and the fins are assembled into one body and brazed in the oven.

Namely, the invention can be applied to a heat exchanger configured by assembling tubes and fins into one body and brazing them in the oven. Basically, the tubes and fins are assembled into one body and brazed in the oven. In addition to the brazing of the tubes and fins, any of the tank, the tank segments configuring the tank and the end plate configuring the tank is brazed at the same time.

Furthermore, in the heat exchanger according to the third aspect of the invention, the tubes, the fins and the tanks are assembled into one body and brazed in the oven.

Namely, the invention can also be applied to the heat exchanger configured by assembling the tubes, the fins and the tank into one body and brazing them in the oven. In this case, the tank is cylindrical or a combination of two pieces formed into a tank body, and brazed with the tubes and the fins into one body.

In addition, in the heat exchanger according to the third aspect of the invention, the tubes, the fins and the tank segments stacked to form the tanks are assembled into one body and brazed in the oven.

Namely, the invention can also be applied to the heat exchanger configured by assembling the tubes, the fins and the tank segments stacked to form the tanks into one body and brazed in the oven. In this case, the above-described laminate type heat exchanger having the tank segments integrally formed with the tubes is brazed into one body.

And, in the heat exchanger according to the third aspect of the invention, the tubes, the fins and an end plate are brazed in the oven and connected to the tanks.

Namely, the invention can also be applied to the heat exchanger configured by brazing the tubes, the fins and the end plate in the oven and connecting to the tanks. In this case, the tubes, the fins and the end plate are brazed in the oven, and connected to the tanks by caulking or the like using a sealing material. This is employed when a pressure resistance required for the heat exchanger is not so high.

As described above, according to the third aspect of the invention, the heat exchanger has the heat exchangers having substantially different applications formed into one body, wherein the tubes satisfying the required performance different for the respective heat exchangers can be formed into one body. Thus, the invention provides the heat exchanger, which has the heat exchangers with different applications configured into one body, with an improved durability, and, at the same time, the maintenance cost of the production equipment is reduced, and the material cost is reduced, thereby the production cost can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front view of the heat exchanger according to an embodiment of a first aspect of the invention.

Fig. 2 is a transverse sectional view of a tube and tanks for the heat exchanger according to an embodiment of the first aspect of the invention.

Fig. 3 is a front view of a sealed section of the tube shown in Fig. 2.

Fig. 4 is a transverse sectional view of a tube and tanks for the heat exchanger according to another embodiment of the first aspect of the invention.

Fig. 5 is a front view of a sealed section of the tube

shown in Fig. 4.

Fig. 6 is a sectional view of passages of a first heat exchanger.

Fig. 7 is a sectional view of passages of a second heat exchanger.

Fig. 8 is a transverse sectional view of a tube and tanks for the heat exchanger according to another embodiment of the first aspect of the invention.

Fig. 9 is a front view of a sealed section of the tube shown in Fig. 8.

Fig. 10 is a transverse sectional view of a tube and tanks for the heat exchanger according to another embodiment of the first aspect of the invention.

Fig. 11 is a front view of a sealed section of tubes shown in Fig. 10.

Fig. 12 is a diagram showing a plate for forming a tube used for a heat exchanger according to another embodiment of the first aspect of the invention.

Fig. 13 is a sectional view of passages of the first heat exchanger where the tube is formed by folding the plate shown in Fig. 12 into halves.

Fig. 14 is a sectional view of passages of the second heat exchanger where the tube is formed by folding the plate shown in Fig. 12 into halves.

Fig. 15 is a front view of a heat exchanger according to another embodiment of the first aspect of the invention.

Fig. 16 is a plan view of the heat exchanger shown in Fig. 15.

Fig. 17 is a plan view of a tube of the heat exchanger shown in Fig. 15.

Fig. 18 is a front view of a heat exchanger having the first and second heat exchangers arranged in a vertical direction according to another embodiment of the first aspect of the invention.

Fig. 19 is a vertical sectional view of a tube and tanks of the heat exchanger shown in Fig. 18.

Fig. 20 is a perspective view of a heat exchanger having the first and second heat exchangers arranged in a vertical direction according to another embodiment of the first aspect of the invention.

Fig. 21 is a perspective view showing a tank section of a heat exchanger having the first and second heat exchangers arranged in a vertical direction according to another embodiment of the first aspect of the invention.

Fig. 22 is a vertical sectional view of a tube of the heat exchanger shown in Fig. 21.

Fig. 23 is a front view of the heat exchanger according to an embodiment of a second aspect of the invention.

Fig. 24 is a perspective view of a joining plate.

Fig. 25 is a perspective view of a joining plate.

Fig. 26 is a perspective view of a joining plate.

Fig. 27 is a perspective view of a joining plate.

Fig. 28 is a perspective view of a joining plate.

Fig. 29 is a perspective view of a joining plate.

Fig. 30 is a perspective view of a joining plate.

Fig. 31 is a perspective view of a joining plate.

Fig. 32 is a sectional view taken along line X-X of section C of the heat exchanger of Fig. 23.

Fig. 33 is an enlarged perspective view of section C of the heat exchanger shown in Fig. 23.

Fig. 34 is a front view of the heat exchanger according to another embodiment of the second aspect of the invention.

Fig. 35 is a front view of the heat exchanger according to another embodiment of the second aspect of the invention.

Fig. 36 is a transverse sectional view of a tube and tanks shown in Fig. 35.

Fig. 37 is a perspective view of the heat exchanger according to another embodiment of the second aspect of the invention.

Fig. 38 is a sectional view taken along line Y-Y of Fig. 37 to show a part of the heat exchanger.

Fig. 39 is a perspective view of the heat exchanger according to an embodiment of a third aspect of the invention.

Fig. 40 is a transverse sectional view of the heat exchanger according to an embodiment of the third aspect of the invention.

Fig. 41 is a perspective view of an end face portion of a tube according to an embodiment of the third aspect of the invention.

Fig. 42 is a perspective view of an end face portion of a tube according to an embodiment of the third aspect of the invention.

Fig. 43 is a perspective view of an end face portion of a tube according to an embodiment of the third aspect of the invention.

Fig. 44 is a perspective view of an end face portion of a tube according to an embodiment of the third aspect of the invention.

Fig. 45 is a perspective view of an end face portion of a tube according to an embodiment of the third aspect of the invention.

Fig. 46 is a perspective view of an end face portion of a tube according to an embodiment of the third aspect of the invention.

Fig. 47 is a perspective view of an end face portion of a tube according to an embodiment of the third aspect of the invention.

Fig. 48 is a perspective view of an end face portion of a tube according to an embodiment of the third aspect of the invention.

Fig. 49 is a perspective view of an end face portion of a tube according to an embodiment of the third aspect of the invention.

Fig. 50 is a perspective view of an end face portion of a tube according to an embodiment of the third aspect of the invention.

Fig. 51 is a perspective view of an end face portion of a tube according to an embodiment of the third aspect of the invention.

Fig. 52 is a perspective view of an end face portion of a tube according to an embodiment of the third

aspect of the invention.

Fig. 53 is a perspective view of an end face portion of a tube according to an embodiment of the third aspect of the invention.

Fig. 54 is a perspective view of the heat exchanger according to another embodiment of the third aspect of the invention.

Fig. 55 is a transverse sectional view of a tube and tanks of the heat exchanger shown in Fig. 54.

Fig. 56 is a perspective view of the heat exchanger according to another embodiment of the third aspect of the invention.

Fig. 57 is a perspective view of the heat exchanger according to another embodiment of the third aspect of the invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Now, embodiments of a first aspect of the invention will be described with reference to the accompanying drawings.

Fig. 1 is a front view of the heat exchanger of this embodiment and Fig. 2 is a transverse sectional view of a tube and tanks for this heat exchanger. This heat exchanger designated by numeral 1 is a heat exchanger having a plurality of tubes 4, 4 and fins 3a, 3a disposed between a pair of tanks 2, 2, the respective tubes 4, 4 have a sealed section 5 to divide a passage into two, and one passage 6 connected to the tank 2 on one side and the other passage 7 connected to the tank 2 on the other side, and each formed to have a U-shape.

In Fig. 2, numerals 60 and 70 denote a ridge, and these ridges 60, 70 are bonded to the plate face, or the ridges 60, 60 or the ridges 70, 70 are mutually bonded, and the passages 6, 7 are respectively formed into the U-shape. Reference numeral 7a denotes beads, and these beads 7a are bonded to the plate face, or the beads 7a, 7a are mutually bonded to improve a pressure resistance and to cause turbulence in the flow of a heat exchange medium, thereby to improve a heat exchange rate. And, Fig. 3 is a front view of the sealed section 5.

And, a first heat exchanger A having a single tank structure is formed of the tank 2 on one side and the passage 6 having the U-shape on one side, and a second heat exchanger B having a single tank structure is formed of the tank 2 on the other side and the passage 7 having the U-shape on the other side of the tube. In this embodiment, the first heat exchanger A is a radiator, the second heat exchanger B is a condenser, and the first and second heat exchangers A, B are horizontally arranged to form the heat exchanger 1.

Both ends of the respective tubes 4, 4 are inserted into connected with tube insertion holes (not shown) of the tanks 2, 2, on both sides. And, side plate connection holes (not shown) are formed at upper and lower ends of the tanks 2, 2, and both ends of side plates 3b having a square C-shaped cross section are inserted into these side plate connection holes. Besides, the respective tanks 2, 2 have partition plates 2a, 2a integrally formed in a longitudinal direction to divide the interior into inlet sides 20A, 20B and outlet sides 21A, 21B. Inlet joints 8A, 8B for the heat exchange medium are connected to the inlet sides 20A, 20B, and outlet joints 9A, 9B are connected to the outlet sides 21A, 21B, respectively.

In this embodiment, the tube 4 is formed by joining two plates which are formed by pressing or rolling, or by folding a single plate formed by pressing or rolling into halves, or by folding a single plate into halves while forming it by rolling. And, the tube is made of a three-layered material of a two-sided clad or a four-layered material having an intermediate layer in a two-sided clad.

In the above-described heat exchanger 1, the heat exchange medium flows through the passages 6, 6 having the U-shape in the respective tubes 4 to undergo heat exchange between the inlet joint 8A and the outlet joint 9A of the first heat exchanger A. Similarly, the heat exchange medium flows through the passages 7, 7 having the U-shape in the respective tubes 4 to undergo heat exchange between the inlet joint 8B and the outlet joint 9B of the second heat exchanger B.

In the heat exchanger 1 configured as described above, even though it is substantially formed by assembling heat exchangers each having a single tank structure (the first and second heat exchangers A, B), alternately stacked multiple tubes 4, 4 and fins 3a, 3a are mounted between the pair of tanks 2, 2, the tubes 4 are integrally formed between the pair of tanks 2, 2, and both ends of the tubes 4, 4 and the fins 3a, 3a are supported by the pair of tanks 2, 2, so that rigidity of the heat exchanger can be increased. Thus, the heat exchanger 1 has an advantage of a parallel flow type heat exchanger even if it has a single tank structure. And, since this embodiment uses the side plates 3b, strength of the heat exchanger 1 is further enhanced.

Since the first and second heat exchangers A, B respectively have the single tank structure (the heat exchanger A has the tank 2 and the heat exchanger B has the tank 2), there is an advantage inherent to the single tank structure, namely the tank is halved as compared with a parallel flow type heat exchanger, and the saved space can be used for the heat exchange. Thus, it is advantageous that the heat exchange efficiency can be improved, the number of parts can be decreased and the cost can be reduced.

Furthermore, since the first and second heat exchangers A, B are connected to form the heat exchanger 1, rigidity is improved as described above, and since the sealed section 5 is formed at the midpoint of the tube 4, the flow of heat exchange medium is stopped there, and heat conduction between the two heat exchangers A, B can be minimized by virtue of the sealed section 5, and lowering of the performance can be prevented. The sealed section 5 also connects passages of both the first and second heat exchangers A, B

to enable the integral formation of the tubes 4.

Preferred embodiments will be described with reference to the drawings. It is to be understood that common components with the above-described embodiment are given like reference numerals and descriptions thereof are omitted.

In Fig. 2, the sealed section 5 of the tube 4 has pores 5a, 5a for heat insulation. Thus, a heat insulation effect can be improved further by the pores 5a, 5a of the sealed section 5.

In the embodiment shown in Fig. 4 through Fig. 7, two plates 4a, 4b are joined to form the tube 4, and pores 5a are formed larger than those of the above described embodiment. And, the plates 4a, 4b are formed by pressing or rolling.

Fig. 6 is a sectional view of a passage 6 of the first heat exchanger A, and Fig. 7 is a sectional view of a passage 7 of the second heat exchanger B, in which ridges 60, 70 are bonded to the plate face to form each passage 6, 7 in a U-shape. The passage 7 has an improved pressure resistance by bonding beads 7a to the plate face and an improved heat exchange efficiency by causing turbulence in the flow of the heat exchange medium.

Fig. 8 and Fig. 9 show another embodiment of the tube 4, in which the sealed section 5 of the tube 4 has a cavity 5b for heat insulation. Accordingly, the heat insulation effect can be improved by the cavity 5b in the same way as in the above-described embodiment.

Fig. 10 and Fig. 11 show another embodiment of the tube 4, which has folded portions 5c, 5c on the sealed section 5 of the tube 4. Further, the first heat exchanger A and the second heat exchanger B are provided with separate fins 3a with their ends positioned at the folded portions 5c, 5c on the sealed section 5.

In this embodiment, since the fins 3a are separately disposed for the first and second heat exchangers A, B, the respective heat exchangers A, B can be provided with the fins having performance suitable for each of them. Thus, the performance required for the respective heat exchangers A, B can be satisfied. And, since the sealed section 5 is provided with the folded portions 5c, 5c, the ends of the respective fins 3a are positioned at the folded parts 5c, 5c. As a result, the fin ends are prevented from extending from the folded portions 5c, 5c, and the fins are held appropriately.

The first and second heat exchangers A, B may be provided with a single fin, though not illustrated. And, the fin may have a different number of ridges in the first and second heat exchangers A, B. Thus, when only one fin is disposed in the first and second heat exchangers A, B, it is economical because only one type of fin is used. And, the number of peaks of the fin can be changed for the first and second heat exchangers thereby the fin pitches can be varied so to suit the required performance of each heat exchanger.

Fig. 12 through Fig. 14 show an embodiment that a single plate 4c is folded into halves to form the tube 4. The tube 4 is formed by further folding the single plate 4c formed by pressing or rolling into halves or by folding the single plate 4c into halves while rolling.

Fig. 15 through Fig. 17 show an embodiment that tank segments 2b, 2b stacked to form tanks 2, 2 are of a laminate type integrally formed with the tubes 4. In this case, the heat exchanger 1 is a heat exchanger having a plurality of tubes 4, 4 and fins 3a, 3a between a pair of tanks 2, 2. The respective tubes 4, 4 have a sealed section 5 at their midpoints to divide passages into two. And a passage 6 on one side connected to one tank 2 and a passage 7 on the other side connected to the other tank 2 are pressed to have a U-shape, respectively.

In the same way as in the above-described embodiment, the tank 2 on one side and the passage 6 having the U-shape on one side of the tube 4 form the first heat exchanger A having a single tank structure. And, the tank 2 on the other side and the passage 7 having the U-shape on the other side of the tube 4 form the second heat exchanger B having a single tank structure. The fins 3a are separately disposed in the first and second heat exchangers A, B. Accordingly, the fins having performance suitable for the respective heat exchangers can be provided, thereby satisfying the required performance of the respective heat exchangers.

As described above, a single fin may be formed for the first and second heat exchangers A, B. And, the fin may have a different number of ridges for the first and second heat exchangers A, B so as to meet the required performance of the respective heat exchangers.

Fig. 18 and Fig. 19 show an embodiment that the first and second heat exchangers A, B are vertically assembled to form the heat exchanger 1. This heat exchanger 1 is a heat exchanger having a plurality of tubes 4, 4 and fins 3a, 3a disposed between the vertically disposed pair of tanks 2, 2. In the same way as in the above-described embodiment, the respective tubes 4, 4 have the sealed section 5 at their midpoints to divide passages into two, and a passage 6 on one side connected to one tank 2 and a passage 7 on the other side connected to the other tank 2 are formed to have a U-shape, respectively. By assembling the first and second heat exchangers A, B vertically as in this embodiment or by assembling them horizontally as in the above-described embodiment, the heat exchanger 1 can be formed to suit the space where it is disposed.

The heat exchanger 1 according to each of the embodiments described above is configured by integrally assembling the tubes 4, 4, and the fins 3a, 3a and brazing them in an oven. Specifically, the heat exchanger 1 shown in each of Fig. 1, Fig. 15 and Fig. 18 is basically produced by integrally assembling the tubes 4, 4 and the fins 3a, 3a and brazing them in the oven, and in addition to the brazing of the tubes and the fins, the tanks 2, 2 (the heat exchangers shown in Fig. 1 and Fig. 18) and the tank segments 2b, 2b configuring the tanks 2, 2 (the heat exchanger shown in Fig. 15) are brazed at the same time to form the heat exchanger. On

the other hand, the heat exchanger shown in each of Fig. 20 through Fig. 22 is of a so-called post-attaching tank and caulking type and a separate tank type.

In an embodiment of Fig. 20, the heat exchanger 1 is produced by assembling the first and second heat exchangers A, B vertically, and having a plurality of tubes 4, 4 and fins 3a, 3a disposed between a pair of tanks disposed vertically. The respective tubes 4, 4 have the sealed section at the midpoint to divide the passage into two in the same way as in the above-described embodiment, the passage on one side connected to the tank on one side and the passage on the other side connected to the tank on the other side are formed into a U-shape, respectively. This heat exchanger 1 has the tubes 4, 4, the fins 3a, 3a and an end plate 2c integrally assembled and brazed in the oven, then a tank plate 2d is fixed to the end plate 2c to form the first heat exchanger A. Specifically, the tank 2 is formed of the end plate 2c and the tank plate 2d by brazing the tubes 4, 4, the fins 3a, 3a and the end plate 2c, assembling the tank plate 2d, and caulking them by a sealing material (not shown). When the heat exchanger is not required to have a very high-pressure resistance, it may be configured to bond components by caulking with a sealing material in the same way as the tank 2 of Fig. 20.

Fig. 21 and Fig. 22 show an embodiment of the heat exchanger 1, which is formed by assembling the first and second heat exchangers, A, B vertically. This heat exchanger 1 has a plurality of tubes 4, 4 and fins 3a, 3a disposed between a pair of tanks disposed vertically. The respective tubes 4, 4 have the sealed section 5 at the midpoint to divide the passage into two in the same way as in the above-described embodiment, the passage on one side connected to the tank on one side and the passage on the other side connected to the tank on the other side are formed to have a U-shape, respectively. This heat exchanger 1 has the tank 2 formed of the end plate 2c and the tank plate 2d in the first heat exchanger A, and the tubes 4, 4, the fins 3a, 3a, the end plate 2c and the tank plate 2d are integrally brazed in the oven.

As described above, the heat exchanger of this embodiment is basically formed by integrally assembling the tubes and the fins and brazing them in the oven. In addition to the brazing of the tubes and the fins, any of the tank, the tank segments forming the tank and the end plates configuring the tank can be brazed at the same time. Specifically, where the tubes, the fins and the tank are integrally assembled and brazed in the oven, the tank is cylindrical or made by integrally assembling two parts and can be brazed integrally with the tubes and the fins. And, the tubes, the fins and the tank segments which are stacked to form the tank are integrally assembled, namely a laminate type having the tank segments integrally formed with the tubes can be brazed in the oven. Besides, it can be configured by a procedure that the tubes, the fins and the end plate are integrally assembled and brazed in the oven, then the tank plate is fixed to the end plate.

In the above-described embodiments, two heat exchangers were assembled horizontally or vertically, but a third heat exchanger can be fitted to either or both of the top and bottom sides of the heat exchanger formed by assembling two heat exchangers horizontally, or a third heat exchanger can be fitted to either or both of the right and left sides of the heat exchanger formed by assembling two heat exchangers vertically. Thus, the heat exchanger may be formed by assembling as required.

Embodiments according to a second aspect of the invention will be described.

Fig. 23 is a front view of the heat exchanger of an embodiment of the second aspect of this invention. This heat exchanger 1 has a plurality of tubes 4A, 4A and fins 3a, 3a configuring a first heat exchanger A and a plurality of tubes 4B, 4B and fins 3a, 3a configuring a second heat exchanger B stacked alternately in parallel to each other between a pair of tanks 2, 2, and both ends of the stacked tubes are inserted into and connect with tube insertion holes formed in the tanks 2. Specifically, the heat exchanger 1 has the pair of tanks 2, 2 erected on both sides of the tubes, both ends of the tubes 4A, 4A configuring the first heat exchanger A are connected to the upper half of the tanks 2, and both ends of the tubes 4B, 4B configuring the second heat exchanger B are connected to the lower half of the tanks 2 so as to connect the first and second heat exchangers A, B in parallel in a vertical direction. In this embodiment, the first heat exchanger A is a radiator, and the second heat exchanger B is a condenser, which are integrally formed into a heat exchanger. And, top and bottom openings of the tanks 2 are sealed by caps 3c. The tanks 2 of this embodiment are formed of a flat sheet material, which is formed into a circular pipe. Side plate connection holes are formed on the tanks 2 at the top and bottom sides of the stacked tubes 4, and both ends of side plates 3b, 3b are inserted into and connect with the side plate connection holes. And, inlet and outlet joints 8A, 9A communicated with the first heat exchanger A and an inlet joint 8B communicated with the second heat exchanger B are connected to the tank 2 on one side, and an outlet joint 9B communicated with the second heat exchanger B is connected to the tank 2 on the other side. Besides, partition plates 10 for dividing the inside of the tanks 2 in a longitudinal direction are disposed at required positions in both tanks 2.

And, in the heat exchanger 1, a heat exchange medium is meandered a plurality of times to flow between the inlet joints 8A, 8B and the outlet joints 9A, 9B. More specifically, the heat exchange medium supplied through the inlet joints 8A, 8B of the heat exchanger 1 is flown to meander a plurality of times from both tanks 2, 2 through the tubes 4A, 4B, which configure the first heat exchanger A and the second heat exchanger B, to perform heat exchange with out-

side while passing through the tubes 4A, 4B, and discharged from the outlet joints 9A, 9B. The tubes 4A, 4B are formed by extrusion molding, by combining two plates formed by pressing or rolling, by folding to half a single plate formed by pressing or rolling, or by folding a single plate into halves while being formed by rolling. And, the tube is made of an extruded material, a three-layered material of a two-sided clad with the brazing material, or a four-layered material having an intermediate layer in a two-sided clad with the brazing material.

The heat exchanger 1 has an heat insulation region 11 having no fin 3a between the tubes 4A configuring the first heat exchanger A and the tubes 4B configuring the second heat exchanger B.

Thus, since the heat insulation region 11 is formed between the first heat exchanger A and the second heat exchanger B, the conduction of heat between the heat exchangers A, B is prevented, and the first heat exchanger A and the second heat exchanger B can perform heat exchange at an optimum temperature. Therefore, this provides a single-body type heat exchanger comprising two heat exchangers without lowering their respective performances.

By forming the first heat exchanger A and the second heat exchanger B having different applications into one body, the heat exchange space is enlarged to improve a heat exchange rate, the number of components is decreased, and the cost can be reduced.

The heat insulation region 11 formed between the vertically adjacent tubes 4A and tubes 4B has a bonding plate 12 having a length substantially equal to those of the tubes 4A, 4B. Thus, the tubes 4A, 4B, the fins 3a, 3a and the bonding plate 12 are integrally brazed in the oven.

Since the heat exchanger 1 includes the heat insulation region 11, the pressure resistance of the heat exchanger may be lowered in the heat insulation region 11 and the heat exchanger 1 may be deformed during production. However, disposing of the bonding plate 12 in the heat insulation region 11 can eliminate the above-described disadvantages and reinforce the heat exchanger 1.

The bonding plate 12 is formed of a flat bonding plate material, which is bent into a rectangular or corrugated shape. The bonding plate is made of a three-layered material of a two-sided clad with the brazing material or a bare material and integrally formed together with the tubes and the fins by brazing in the oven. Especially, when the flat bonding plate is bent to be brazed as the bonding plate 12, the bonding plate can have an improved pressure resistance, and an area of heat conduction can be decreased to prevent the heat conduction between the two heat exchangers.

Preferred embodiments of the bonding plate 12 will be described with reference to the drawings.

Fig. 24 through Fig. 31 show embodiments of the bonding plates each formed by bending the bonding plate into a rectangular or corrugated shape. A direction of long sides of the flat bonding plate material is determined as a longitudinal direction, a direction of short sides is determined as a perpendicular direction, the long sides are expressed as long ends, and the short sides are simply expressed as ends.

As shown in Fig. 24, both ends of the bonding plate are bent two times in a vertical direction to form end joints 12a having a square side shape with its part opened, and the middle flat portion is bent in a vertical direction to form projections and depressions at an equal interval, thereby forming a bonding plate 12 (1) having a plurality of projections 12b and a plurality of depressions 12c. The bonding plate 12 (1) has its pressure resistance at both ends improved by the end joints 12a and also the pressure resistance in the middle improved by the plurality of projections 12b and depressions 12c. Since the bonding plate 12 (1) is formed to have the projections and depressions, the flat faces of the end joints 12a and the flat faces of the projections 12b are in contact with the tube 4A, and the flat faces on the other side of the end joints 12a and the flat faces of the depressions 12c of the bonding plate 12 (1) are in contact with the tube 4B, so that a heat conducting area between the bonding plate 12 (1) and the tubes 4A, 4B is decreased, and the heat conduction between the first heat exchanger and the second heat exchanger can be decreased.

Fig. 25 shows an embodiment which uses a bonding plate having a length substantially a half, upon bending, of the length of the tube 4 in a longitudinal direction, its both ends are bent in a vertical direction two times to form a bonding plate 12 (2) having a rectangular joint 12d at both ends. Two bonding plates 12 (2) are disposed in the heat insulation region 11 to reinforce the heat insulation region 11.

A bonding plate 12 (3) shown in Fig. 26 is formed by bending both ends of the bonding plate in a vertical direction into a rectangular shape to form a bonding joint 12e having an L-shape inward of the bonding plate 12 (3) at both ends, entering two L-shaped cuts from both long ends at a given interval on the middle flat face, bending four portions formed by cutting in a vertical direction two times to form four L-shaped projections 12f having a height substantially equal to that of the projection 12e.

Fig. 27 shows a bonding plate 12 (4) having a corrugated shape formed by sequentially bending the bonding plate in a vertical direction.

Fig. 28 shows a bonding plate 12 (5) having bonding joints 12g formed by bending both long ends of the bonding plate in a longitudinal direction into a rectangular shape.

Fig. 29 shows a bonding plate 12 (6) configured to have a plurality of holes 12h on the flat face of the bonding plate 12 (5).

Fig. 30 shows a bonding plate 12 (7) formed by bending both long ends of the bonding plate in a longitudinal direction into a rectangular shape and bending

its flat portion in a longitudinal direction to make a depression 12i.

Fig. 31 shows a bonding plate 12 (8) formed by bending the bonding plate in a longitudinal direction into a corrugated shape.

The bonding plate 12 shown in each of the above-described embodiments is formed by bending the bonding plate to improve reinforcement of the heat exchanger for the pressure resistance or the like and also serves to decrease the area of heat conduction between the tubes 4A configuring the first heat exchanger A and the tubes 4B configuring the second heat exchanger B to prevent the heat conduction between them. And, when the bonding plate 12 is formed by bending in a vertical direction or a longitudinal direction into the corrugated shape to form such as the bonding plate 12 (4) and the bonding plate 12 (8), bending is preferably made at a predetermined interval because excessively fine bending provides the same effects as the fins.

As to the heat exchanger, description will be made of a cavity formed in the tank by sealing the tank interior by disposing two partition plates in the tank between the tubes configuring the first heat exchanger A and the tubes configuring the second heat exchanger B which are connected to the tank.

Fig. 32 is a partially sectional view (part C in Fig. 23) of the heat exchanger 1. Fig. 33 is a perspective view showing a part (part C in Fig. 23) of the tank 2 and the partition plate 10 configuring the heat exchanger 1. An arrow mark in the Figure denotes a direction of gravitation.

As shown in Fig. 32, the heat insulation region 11 is formed between the tube 4A and the tube 4B, and two slits 13, 13 having a predetermined shape are formed in the tank 2 which is on an extension of the heat insulation region 11, namely between the tube 4A and the tube 4B. The partition plate 10 is formed to have a large diameter portion 10a corresponding to the outer periphery of the tank 2, a small diameter portion 10b corresponding to the inner periphery of the tank 2, and shoulders 10c formed between the large diameter portion 10a and the small diameter portion 10b. When the two partition plates 10, 10 are inserted and brazed in the slots 13, 13, the inside of the tank 2 is sealed by the two partition plates 10, 10 to form a cavity 14. And, a communication hole 15 to communicate the inside of the cavity 14 with the outside is formed on a lower part in a direction of gravitation of the outer wall of the tank 2 configuring the cavity 14.

Thus, formation of the cavity 14 in the tank 2 located between the first heat exchanger A and the second heat exchanger B can prevent the heat conduction between the heat exchangers A, B by virtue of the heat sealing region 11, and, the heat exchangers A, B having a different application can be formed into one body to have a common tank without degrading the performance of the first heat exchanger A and the second heat exchanger B. And, by forming the communication hole 15 for communicating the cavity 14 with the outside, a bypass leak can be checked from the communication hole 15 if a defective product with the interior of the tank 2 not sealed is produced due to a defective bonding or a defective brazing of the partition plates 10, 10, so that early finding of a defective product is possible.

Air or the like may permeate into the cavity 14 and be transformed into water depending on temperature and pressure conditions to accumulate in the cavity 14. But, since the communication hole 15 is formed on the lower part in a direction of gravitation of the outer wall of the tank 2 configuring the cavity 14, water accumulated in the cavity 14 can be discharged from there with ease, and the tank 2 can be prevented from being corroded by the accumulated water.

Other preferred embodiments will be described with reference to the drawings. It is to be understood that common components are given like reference numerals and descriptions thereof are omitted.

Fig. 34 shows an embodiment of a heat exchanger 1 formed by disposing horizontally first and second heat exchangers A, B horizontally and in parallel. The heat exchanger 1 is a heat exchanger formed by vertically connecting a plurality of tubes 4A, 4B and fins 3a, 3a between a pair of tanks 2, 2 disposed vertically. And, a heat insulation region 11 is formed between the tubes 4A configuring the first heat exchanger A and the tubes 4B configuring the second heat exchanger B which are adjacent horizontally. A bonding plate 12 is provided in the heat insulation region 11. And, two partition plates 10, 10 are disposed to seal the inside of the tanks 2 to form a cavity (not shown) between the tubes 4A and the tubes 4B of the top and bottom tanks 2 to which connected are the tubes 4A configuring the first heat exchanger A and the tubes 4B configuring the second heat exchanger B which are adjacent horizontally. A communication hole 15 for communicating the cavity with the outside is formed on the lower part in a direction of gravitation of the outer wall of the tank 2 having the cavity.

Fig. 35 and Fig. 36 show an embodiment of a laminate type heat exchanger in that tank segments 2b, 2b stacked to form a tank 2 are integrally formed with tubes 4A, 4B. In this case, this heat exchanger 1 is a single tank type having the tank segments 2b, 2b and fins 3a, 3a between a plurality of tubes 4, 4. The tubes 4A, 4B are provided with a ridge 22 formed as partition from one end integral with the tank 2 to near the other end. This ridge 22 forms going and return passages in a longitudinal direction for the heat exchange medium, and the passages are in a U-shape at the other end in the tubes 4A, 4B.

In the same way as in the previously described embodiment, a heat insulation region 11 without any fin 3a is formed between the tubes 4A configuring the first heat exchanger A and the tubes 4B configuring the second heat exchanger B which are adjacent horizontally,

and a bonding plate 12 is provided in the heat insulation region 11. Therefore, the heat conduction between the first heat exchanger A and the second heat exchanger B is prevented by the heat insulation region 11, and the respective heat exchangers A, B can have the respective required performance.

Fig. 37 and Fig. 38 show an embodiment that tubes 4A, 4B and fins 3a, 3a configuring first and second heat exchangers A, B are vertically connected to a tank 2 to combine the first and second heat exchangers A, B in parallel to form a single tank type heat exchanger 1. And, a heat insulation region 11 is formed without any fin 3a between the tubes 4A configuring the first heat exchanger and the tubes 4B configuring the second heat exchanger which are adjacent horizontally, and a bonding plate 12 is disposed in the heat insulation region 11. The tubes 4A, 4B are provided with a ridge 22 formed as partition from one end integrally formed with the tank 2 to near the other end. This ridge 22 forms going and return passages for the heat exchange medium in a longitudinal direction within the tubes 4A, 4B, and the passages are formed in a U-shape at the other end. This heat exchanger 1 has the tank 2 formed of an end plate 2c and a tank plate 2d. And, the tubes 4A, 4B, the fins 3a, 3a and the end plate 2c are integrally assembled and brazed in the oven, the tank plate 2d is fixed to the end plate 2c by torch brazing, welding, caulking or the like.

Or, the tubes 4A, 4B, the fins 3a, 3a, the end plate 2c and the tank plate 2d may be brazed integrally in the oven.

In the heat exchanger 1 of this embodiment, the inside of the tank 2 is sealed by two partition plates 10, 10 which are disposed between the tubes 4A and the tubes 4B of the tank 2 connected with the tubes 4A configuring the first heat exchanger A and the tubes 4B configuring the second heat exchanger B. Thus, a cavity 14 is formed in the tank 2, and a communication hole 15 is formed on the lower part in a direction of gravitation of the outer wall of the tank 2 having the cavity 14. Thus, this embodiment has the communication hole 15 formed in the end plate 2c.

As described above, the heat exchanger of this embodiment is formed by integrally assembling the tubes and the fins and brazing them in the oven. In addition to the brazing of the tubes and the fins, any of the bonding plate, the tank, the tank segments forming the tank and the end plate configuring the tank can be brazed at the same time. The tank is formed of a tank material which is rolled into a circular pipe, a two-split material, or the tubes, the fins and the tank segments forming the tank are integrally assembled, namely a laminate type having the tank segments integrally assembled to the tubes, and brazed in the oven.

In the embodiment described above, two heat exchangers are combined horizontally or vertically. But, it is to be understood that a third heat exchanger can be fitted to either or both of the upper and lower heat exchangers formed by combining two heat exchangers horizontally, or a third heat exchanger can be fitted to either or both of the right and left sides of the heat exchanger formed by assembling two heat exchangers vertically. Thus, the heat exchanger may be formed by assembling as required.

Embodiments of a third aspect of the invention will be described.

Fig. 39 is a perspective view of the heat exchanger of this embodiment, and Fig. 40 is a transverse sectional view of the heat exchanger. This heat exchanger 1 is a heat exchanger having a plurality of fins 3a, 3a and tubes 4, 4 alternately stacked parallel to each other between a pair of tanks 2, 2. As will be described hereinafter, the passages in the tubes 4 are divided into two by a sealing section 5. The tanks 2, 2 have a partition plate 2a integrally formed in a longitudinal direction to divide the interior into the tanks 2A, 2A of the first heat exchanger A and the tanks 2B, 2B of the second heat exchanger B, and inlet joints 8A, 8B are connected to one tank and outlet joints 9A, 9B are connected to the other tank. And, upper and lower end openings of the tanks 2A, 2B are sealed by caps 3c, 3c. A side plate connecting hole (not shown) is formed in the tanks 2 on the top and bottom of the stacked tubes 4, 4, and both ends of side plates 3b, 3b having a square C-shaped cross section are inserted into the side plate connecting holes. And, partition plates (not shown) are disposed on required positions of the tank 2B to divide in a longitudinal direction the interior of the tank 2B of the second heat exchanger B into a plurality of sections. In this embodiment, the first heat exchanger A is a radiator and the second heat exchanger B is a condenser. The first and second heat exchangers A, B are disposed downstream and upstream of an air flow direction to form the heat exchanger 1.

As shown in Fig. 41, the tube 4 is formed by bonding both ends 4m, 4n of two plates at both ends of the tube, the tube 4 has its passage divided into two in its longitudinal direction by the sealing section 5 to form a passage 6 on one side connected to the tanks 2A, 2A and a passage 7 on the other side connected to the tanks 2B, 2B. And, the heat exchange medium is flown through the passages 6, 7 of the tubes 4 between the inlet joints 8A, 8B and the outlet joints 9A, 9B to perform heat exchange. The passage 7 has beads 7a, 7a having a U-shaped cross section to protrude inward of the tube, and the leading ends of the beads 7a are in contact with the plate. The beads 7a have an ellipse shape.

Thus, by forming the beads 7a, 7a on the passage 7 on one side, a pressure resistance of the tube 4 is improved, and appropriate turbulence is caused in the flowing heat exchange medium to improve a heat exchange rate. Thus, the required performance of the respective heat exchangers can be satisfied.

And, the tube 4 can decrease the heat conduction between the heat exchangers as low as possible by the sealed section 5 formed and prevent the heat conduc-

tion between the heat exchangers to improve the heat exchange rate. Besides, the sealed section 5 of the tube 4 has holes 5a, 5a for heat insulation. Thus, the heat insulating effect can be improved additionally by the holes 5a, 5a formed in the sealed section 5.

The tube material is a three-layered material formed of an alloy (Al-Mn based) of JIS A 3003 as a core and both a layer forming the inner face of the tube and a layer forming the outer face of the tube clad with an alloy (Al-Si based) of JIS A 4045 as a brazing material, or a four-layered material formed of an alloy (Al-Mn based) of JIS A 3003 as a core and a layer forming the intermediate of the tube being clad with a 1000-based (99.0 wt% Al) aluminum alloy and both a layer forming the inner face of the tube and a layer forming the outer face of the tube clad with an alloy (Al-Si based) of JIS A 4045 as a brazing material.

As described above, since the layer forming the inner face of the tube and the layer forming the outer face are clad with the brazing material, the potential of the core material is determined high owing to a potential difference between the core material and the brazing material, and the outer and inner faces of the tube can have an improved corrosion resistance owing to a sacrificial anode effect of the brazing material. And, when the tube is formed of a four-layered material having an intermediate layer with a potential lower than that of the core material between the core material and the brazing material, the inner face of the tube has an improved pitting corrosion resistance owing to sacrificial corrosion prevention uniformly effecting on the surface of the intermediate layer.

And, when the tube is formed of a three-layered material having both sides of a core material clad with a brazing material or a four-layered material having the core material and the intermediate layer clad with a brazing material, the tube itself has an improved pressure resistance.

In addition to this embodiment, an aluminum material or an aluminum alloy used for a three-layered material or a four-layered material is, for example, an aluminum alloy having Si and Mg added, and used to deposit an intermetallic compound Mg2Si, thereby providing an effect of improving the strength of the material and an effect of improving the structural strength of the heat exchanger or an alloy containing elements for improving a corrosion resistance of the brazing material may be used.

And, since the tube has the sealed section, the heat conduction of both heat exchangers can be decreased as low as possible, so that the heat conduction between the respective heat exchangers can be prevented, and the heat exchange rate can be improved.

As described above, the tube having the improved corrosion resistance and pressure resistance can be produced. Therefore, for example, when both inner and outer faces of the tube are required to have a high corrosion resistance like a radiator is used for the first heat exchanger A, and the inner face of the tube is not required such a high corrosion resistance like a condenser used for the second heat exchanger B, but the outer face of the tube is required to have a corrosion resistance and a pressure resistance, the tubes satisfying the required performance different for the respective heat exchangers can be formed integrally, and the number of components can be decreased when a heat exchanger is formed by having the first and second heat exchangers formed into one body, and the production cost can be reduced.

Since the tubes 4 are made of an aluminum material or aluminum alloy having both sides clad with the brazing material, the fins 3 can be made of a bare material of an aluminum alloy not clad with the brazing material as the fin material. For example, an alloy (Al-Mn based) of JIS A 3003 added with 1.5% of Zn can be used, and since the fin is made of a material not clad with the brazing material, abrasion of a die for making the fins can be decreased, and the maintenance cost can be reduced. And, since the fins can be produced using a material not clad with the brazing material, the material cost can be reduced, and the production cost can also be reduced.

Besides, since the fin material is added with 1.5% of Zn, when the tubes 4 and the fins 3a are assembled into one body, the tubes have a high potential. Therefore, the outer face of the tube is prevented from being corroded by virtue of the sacrificial anode effect while the fins 3a are corroded first, and the corrosion resistance of the outer face of the tube is improved.

Preferred embodiments of tubes formed of the aluminum material or aluminum alloy of the above-described three-layered material or four-layered material with both sides clad with the brazing material will be described with reference to the drawings. It is to be understood that common components are given like reference numerals and descriptions thereby are omitted.

Fig. 42 through Fig. 44 are perspective views showing embodiments of the tubes 4, which are formed of two plates in the same manner as shown in Fig. 41 and viewed, from their end faces.

As shown in Fig. 42, the tube 4 is formed of plates which are bent to protrude beads 7b inward, the beads 7b are formed in a longitudinal direction of the tube 4, and the leading ends of the beads 7b are in contact with the surface of each opposed plate.

And, the tube 4 shown in Fig. 43 has beads 7c which are protruded inward and to have a U-shaped cross section, and the beads 7c are also formed in a longitudinal direction of the tube 4 in this case. And, the leading ends of the beads 7c are in contact with the surface of each opposed plate.

The tube 4 shown in Fig. 44 has circular beads 7d having a U-shaped cross section protruded inward. And the leading ends of the beads 7d are in contact with the surface of each opposed plate.

The above-described embodiments have two

plates to form the tubes, but the beads can also be formed in the same way on the tube formed by folding a single plate formed by pressing or rolling into halves or the tube formed by folding a single plate into halves while rolling.

Fig. 45 through Fig. 48 are perspective views showing embodiments of the tubes viewed from the end faces of the tubes. There are shown embodiments of the tubes 4 formed by folding a single plate into halves to join the plate ends 4m, 4n at one end of the tube.

In Fig. 45, the tube 4 is formed to have long beads 7e, 7e having a U-shaped cross section to protrude inward in a passage 7 on one side, and the long beads 7e, 7e have an ellipse plane form. The leading ends of the beads 7e are mutually contacted.

As shown in Fig. 46, the tube 4 is formed to have beads 7f in a longitudinal direction of the tube by bending a plate so as to protrude inward, and the leading ends of the beads 7f, 7f are mutually contacted.

Fig. 47 shows that the tube 4 is formed to have beads 7g having a U-shaped cross section so to protrude inward, and the leading ends of the beads 7g, 7g are mutually contacted.

Fig. 48 shows that the tube 4 is formed to have circular beads 7h having a U-shaped cross section so to protrude inward, and the leading ends of the beads 7h, 7h are mutually contacted.

Fig. 49 shows another embodiment of the tube 4 comprising a plurality of beads 7c, 7c formed in a passage 7 on one side and a bead 6c also formed to protrude inward of a passage 6 on the other side, and the beads 6c, 7c are in contact with the opposed flat faces. In this embodiment, the beads 6c, 7c are long beads formed in a longitudinal direction of the tube.

In this embodiment, the beads are formed in the passage on one side and in the passage on the other side as well to improve the heat exchange rate and also to satisfy the required performance such as a pressure resistance and the like for the respective heat exchangers.

Fig. 50 through Fig. 53 are perspective views showing other embodiments of the tube viewed from their end faces. In the same way as in the above-described embodiment, the tube 4 is formed of a single plate, except that the ends of the plate were joined in a different way and the joining points are changed.

Fig. 50 shows that the tube 4 is formed to have long beads 7c in a passage 7 on one side to protrude inward along a longitudinal direction of the tube, and the leading ends of the beads 7c are in contact with the opposed flat faces of the plate. Both ends 4m, 4n of the plate are bent to protrude inward of the tube, and the bent ends 4m, 4n are mutually joined by their flat faces.

Fig. 51 shows that the tube 4 is formed to have a plurality of long beads 7c in a passage 7 on one side in a longitudinal direction of the tube. And, one end 4m of the plate is bent to have an L-shape on the passage 7 so to be in contact with the opposed face of the plate, and the other end 4n of the plate is also bent to have the L-shape on the same position so to be overlaid on the end 4m of the plate. In other words, the ends 4m, 4n of the plate form a long bead having a U-shaped cross section.

Fig. 52 shows that the tube 4 is formed to have long beads 7c in a passage 7 on one side, and the plate ends 4m, 4n are mutually overlaid and bonded on the flat faces where a bead 7c is not formed. Specifically, a bead 7c', which is in contact with a flat face where the plate ends 4m, 4n are bonded, is formed to have a U-shaped cross section with a height lower than those of other beads, and the plate end 4m and the plate end 4n are overlaid and bonded on the flat face of the tube where the bead 7c' is contacted.

Fig. 53 shows that the tube 4 is formed to have a plurality of beads 7c in a passage 7 on one side, the ends 4m, 4n of the plate are bent to protrude inward at the center of a passage 6 on the other side so that the surfaces of the bent ends 4m, 4n are mutually contacted and also in contact with the flat face of the tube. In other words, the plate ends 4m, 4n are bonded to form the tube and also serve as a bead to divide the passage 6.

As described above, when the tube is made of a single plate, the plate ends are joined not to protrude outward at the formed tube ends, but the joining style and joining portions are changed so to join the plate material at the tube end, bead position, flat face or passage. Therefore, the tube has an appearance with substantially the same shape on both sides thereof. Thus, it is not necessary to form the tube insertion holes having different shapes on the tanks on both sides, unlike the conventional one, so that the production facilities can be decreased, the assembling property of the tubes can be improved, and the production process can be simplified. And, since the plate ends are joined on a layer which becomes the outer face of the tube, when a tube not required to have a corrosion resistance on its inner face is formed or when an intermediate layer having electric potential different from the core material is coated on a layer which becomes the inner face of the tube, the layer becoming the inner face of the tube is not required to be clad with the brazing material, and the production cost can be reduced.

Fig. 54 and Fig. 55 show an embodiment that first and second heat exchangers A, B, each is a single tank type, are combined parallel to form a heat exchanger 1. The heat exchanger 1 shown in Fig. 54 is a heat exchanger having a plurality of tubes 4, 4 and fins 3a, 3a which are connected to tanks 2A, 2B. The respective tubes 4, 4 are formed of a single or two plates of an aluminum material or aluminum alloy of a three-layered or four-layered material of a two-sided clad with the brazing material in the same way as the previously described embodiments.

As shown in Fig. 55, the tube 4 has its passage divided in a longitudinal direction of the tube by a sealed section 5 to form a passage 6 on one side connected to

one tank 2A and another passage 7 on the other side connected to the other tank 2B. Ridges 60, 70 are formed at the middle of the respective passages 6, 7 to be in contact with the surface of the plate, or the ridges 60, 60 or the ridges 70, 70 are mutually contacted to form the respective passages 6, 7 each having a U-shape. Reference numerals 7a, 7a denote ellipse beads, and these long beads 7a, 7a are in contact with the surface of the plate, or the long beads 7a, 7a are mutually contacted. This configuration is sufficient with a tank which is a half as compared with a parallel flow-type heat exchanger, an area in contact with air is increased accordingly, and a heat exchange rate is improved. And, there are also advantages that the number of components is decreased, and the cost is reduced.

Fig. 56 shows an embodiment that first and second heat exchangers A, B, each is a single tank type, are disposed in parallel to position the tanks alternately, a tank 2A being on the left and a tank 2B on the right side. A plurality of tubes 4, 4 and fins 3a, 3a are disposed between the tank 2A and the tank 2B, the tubes 4, 4 are provided with the sealed section 5 to divide the passage in the same way as the previously described embodiments, a passage 6 on one side connected to one tank 2A and other passage 7 on the other side connected to the other tank 2B are each formed to have a U-shape. And, the tubes 4, 4 are formed of a single or two plates of an aluminum material or aluminum alloy of a three-layered or four-layered material of a two-sided clad with the brazing material, and the fins are formed of an aluminum material or aluminum alloy containing 1.5% of Zn. The heat exchanger formed by assembling the first and second heat exchangers A, B described above can be mounted on a vehicle body with brackets fitted to its both sides, and assemblability can be improved.

Fig. 57 shows an embodiment that stacked tank segments 2b, 2b forming tanks 2A, 2B are of a laminate type and integrally formed with tubes 4, 4. In this case, the heat exchanger 1 is also a heat exchanger having a plurality of tubes 4, 4 disposed between two pairs of tanks 2A, 2A and 2B, 2B disposed in parallel, the respective tubes 4, 4 have a sealed section 5 to divide the passage in a longitudinal direction to form a passage 6 on one side connected to the tanks 2A, 2A on one side and a passage 7 on the other side connected to the tanks 2B, 2B on the other side. And, in the same way as in the previously described embodiments, the tubes 4, 4 are formed of a single or two plates of an aluminum material or aluminum alloy of a three-layered or four-layered material of a two-sided clad with the brazing material, and the tubes satisfying the required performance of the respective heat exchangers are formed into one body.

Thus, the heat exchanger of this embodiment is basically formed by integrally assembling tubes and fins and brazing them in the oven, and in addition to the brazing of the tubes and fins, any of a bonding plate, a tank and tank segments configuring the tank can be brazed at the same time. The tank is formed of a tank material which is rolled into a circular pipe or a two-split material, and the tubes, the fins and the tank segments to be stacked to form the tank are integrally assembled, namely a laminate type having the tank segments integrally assembled to the tubes, and brazed in the oven.

The above-described embodiment has two heat exchangers assembled in parallel and horizontally to form the heat exchanger. But, two heat exchangers may be assembled in parallel and vertically, or a third heat exchanger can be fitted to either or both of the upper and lower heat exchangers formed by two heat exchangers. Thus, the heat exchanger may be formed by assembling and combining the heat exchangers as required.

INDUSTRIAL APPLICABILITY

The invention is applied to heat exchangers for automobiles and home uses, and more particularly to a heat exchanger combining a radiator and a condenser for automobiles.

Claims

1. A heat exchanger comprising a pair of tanks, and a plurality of tubes and fins disposed between the tanks, characterized in that

   each tube includes a sealed section at the midpoint to divide a passage into two passages each in a U-shape, the U-shaped passage on one side is connected to the tank on one side and the U-shaped passage on the other side is connected to the tank on the other side, and
   the U-shaped passage and the tank on one side of the tube configure a first heat exchanger having a single tank structure, and
   the U-shaped passage and the tank and on the other side of the tube configure a second heat exchanger having a single tank structure.

2. The heat exchanger as set forth in Claim 1, wherein each tube is formed of two plates which are joined together, or a single plate which is folded into halves.

3. The heat exchanger as set forth in Claim 1, wherein the tubes are integrally formed with tank segments which are laminated to form the tank.

4. The heat exchanger as set forth in Claim 1, wherein the sealed section of the tube includes heat-insulating holes.

5. The heat exchanger as set forth in Claim 1, wherein the sealed section of the tube includes a heat-insu-

lating cavity.

6. The heat exchanger as set forth in Claim 1, wherein the sealed section of the tube has a folded portion, the first and second heat exchangers are provided with separate fins, and the ends of the fins are positioned at the folded portion of the sealed section.

7. The heat exchanger as set forth in Claim 1, wherein a single fin is provided for each of the first heat exchanger and the second heat exchanger, and said fins have different numbers of ridges between the first and second heat exchangers.

8. The heat exchanger as set forth in Claim 1, wherein the tubes and fins are integrally assembled and brazed in an oven.

9. The heat exchanger as set forth in Claim 1, wherein the tubes, fins and tanks are integrally assembled and brazed in an oven.

10. The heat exchanger as set forth in Claim 3, wherein the tubes, fins and tank segments laminated to form the tank are integrally assembled and brazed in an oven.

11. The heat exchanger as set forth in Claim 1, wherein the tubes, the fins and an end plate are integrally assembled and brazed in an oven, and, subsequently, a tank plate is joined to the end plate.

12. The heat exchanger as set forth in Claim 1, wherein a side plate is disposed between the pair of tanks.

13. A heat exchanger comprising a single tank or a pair of tanks, and a plurality of tubes and fins stacked alternately, and the ends of the tubes being inserted into tanks, characterized in that

    the heat exchanger body formed by alternately stacking the tubes and fins is divided into a first heat exchanger and a second heat exchanger, and
    a heat insulation region without a fin is disposed between the divided first and second heat exchangers.

14. The heat exchanger as set forth in Claim 13, wherein the first and second heat exchangers are disposed vertically or horizontally adjacent to each other, and a bonding plate is disposed in the heat insulation region to connect the adjacent first and second heat exchangers.

15. The heat exchanger as set forth in Claim 13, wherein the tank is provided with partition means to provide partition between the first and second heat exchangers.

16. The heat exchanger as set forth in Claim 15, wherein the partition means comprises at least two partition plates, and a cavity is formed by the two partition plates in the tank.

17. The heat exchanger as set forth in Claim 16, wherein the cavity includes a communication hole to communicate with the outside.

18. The heat exchanger as set forth in Claim 13, wherein the first and second heat exchangers are disposed between the pair of tanks, each tube includes a sealed section at the midpoint to divide a passage into two passages each having a U-shape, the U-shaped passage on one side is connected to the tank on one side and the U-shaped passage on the other side is connected to the tank on the other side, the U-shaped passage and the tank on one side of the tube form the first heat exchanger having a single tank structure, and the other U-shaped passage and the other tank on the other side form the second heat exchanger having the single tank structure, and the heat insulation region is formed in the sealed section dividing the tube.

19. The heat exchanger as set forth in Claim 13, wherein the first and second heat exchangers, each having a single tank structure, are disposed horizontally or vertically adjacent to each other, and the tubes are integrally formed with the tank segments laminated to form the tank.

20. A heat exchanger comprising tubes configuring a first heat exchanger and tubes configuring a second heat exchanger, wherein the tubes are respectively disposed at downstream and upstream of an air flowing direction, ends of the tubes are inserted into tanks respectively to form the first and second heat exchangers, and the first and second heat exchangers are integrally brazed, characterized in that

    each tube is formed by folding a single plate into halves or joining two plates, the plate being made of an aluminum material or aluminum alloy with both sides clad with a brazing material, each tube includes a sealed section to divide its passage into two passages in a longitudinal direction of the tube, the passage on one side forms the first heat exchanger and the passage on the other side forms the second heat exchanger, and
    fins are disposed between the tubes, said fins being made of an aluminum material or aluminum alloy not clad with a brazing material.

21. The heat exchanger as set forth in Claim 20, wherein the tube is made of a three-layered material formed of a core material of an aluminum material or aluminum alloy, and a layer forming the inner face of the tube and a layer forming the outer face of the tube, both layers clad with an Al-Si based brazing material; or a four-layered material formed of the core material of the aluminum material or aluminum alloy, an intermediate layer clad with an aluminum material or aluminum alloy having a potential lower than that of the core material, and a layer forming the inner face of the tube and a layer forming the outer face of the tube, both layers clad with the Al-Si based brazing material.

22. The heat exchanger as set forth in Claim 20, wherein each tube has a flat face and includes a plurality of projections formed in the passage on one side or in the passages on both sides, said projections protruding inwardly of the passage, and tips of the projections are mutually contacted or in contact with the flat face of the tube.

23. The heat exchanger as set forth in Claim 20, wherein the tube is formed of a single plate which is folded into halves, and ends of the plate forming the tube are overlaid and brazed on a bead portion, flat portion, end portion, or passage portion of the tube.

24. The heat exchanger as set forth in Claim 20, wherein each tube includes one passage formed in a U-shape on one side and connected to a tank on one side and the other passage formed in the U-shape on the other side and connected to a tank on the other side, the U-shaped passage and the tank on one side of the tube form a first heat exchanger having a single tank structure, and the other U-shaped passage and the other tank on the other side form a second heat exchanger having the single tank structure.

25. The heat exchanger as set forth in Claim 20, wherein the tube includes heat insulation holes formed in the sealed section which divides the passage.

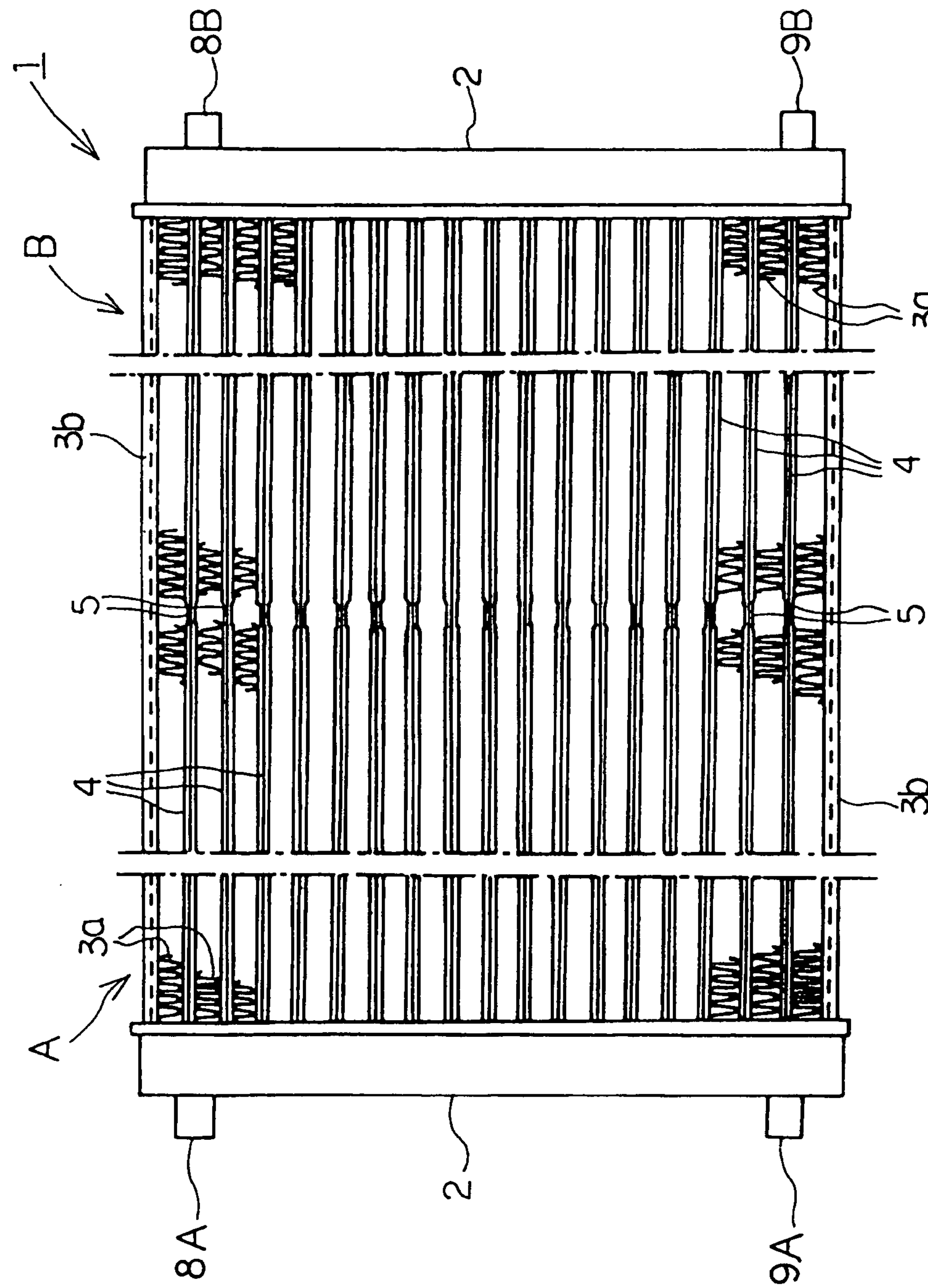
26. The heat exchanger as set forth in Claim 20, wherein the tubes and the fins are integrally assembled and brazed in an oven.

27. The heat exchanger as set forth in Claim 20, wherein the tubes, the fins and the tanks are integrally assembled and brazed in an oven.

28. The heat exchanger as set forth in Claim 20, wherein the tubes, the fins and the tank segments laminated to form the tank are integrally assembled and brazed in an oven.

29. The heat exchanger as set forth in Claim 20, wherein the tubes, the fins and an end plate are integrally brazed in an oven and, subsequently, connected to the tanks.

FIG.1



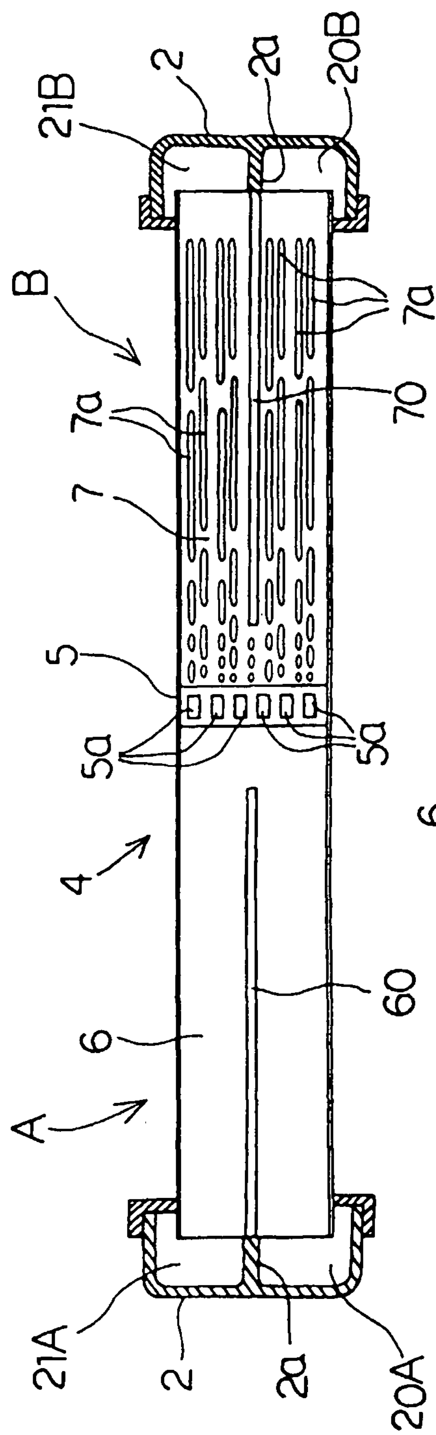


FIG.2

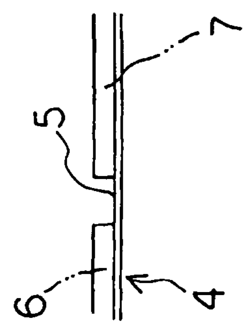
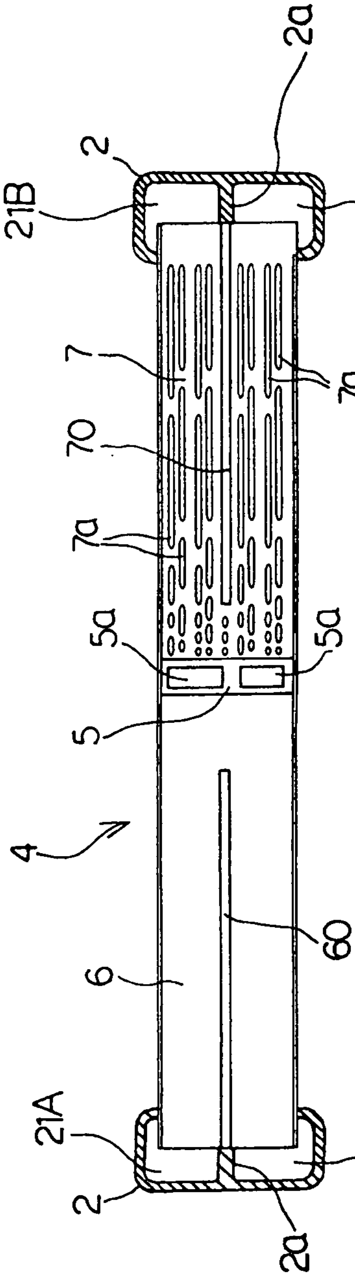


FIG.3

FIG.4



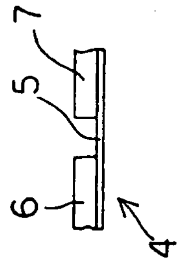


FIG.5

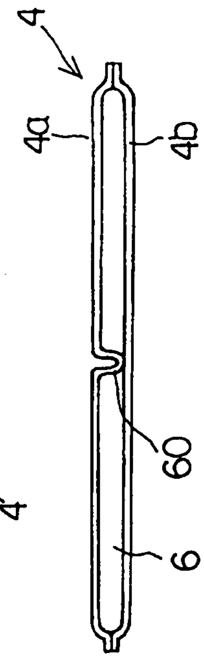


FIG.6

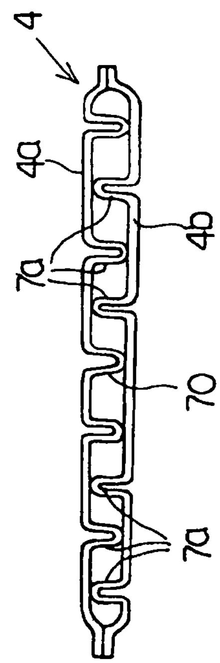


FIG.7

FIG.8

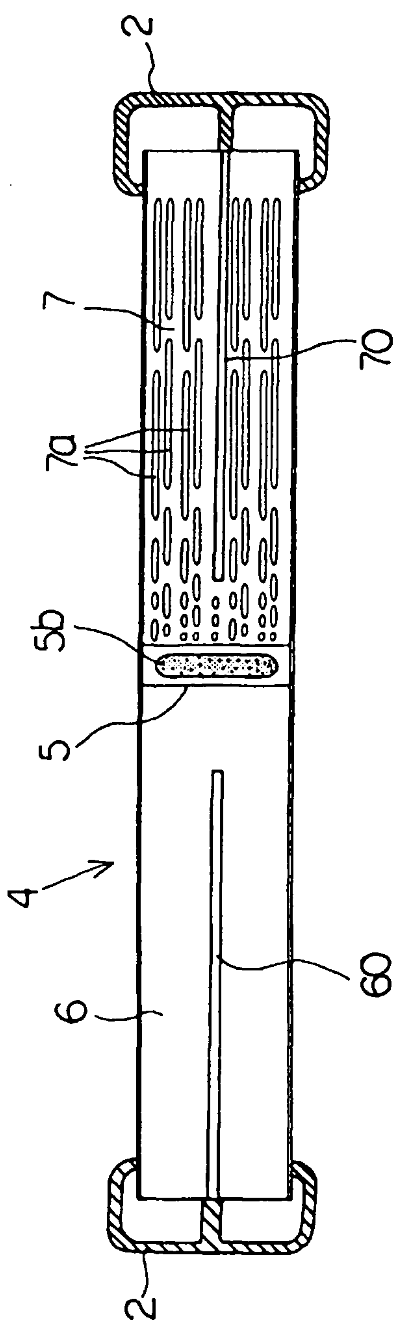


FIG.9

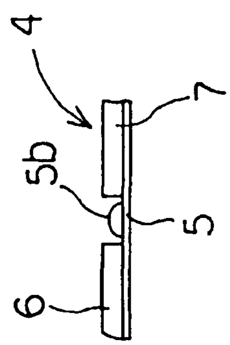
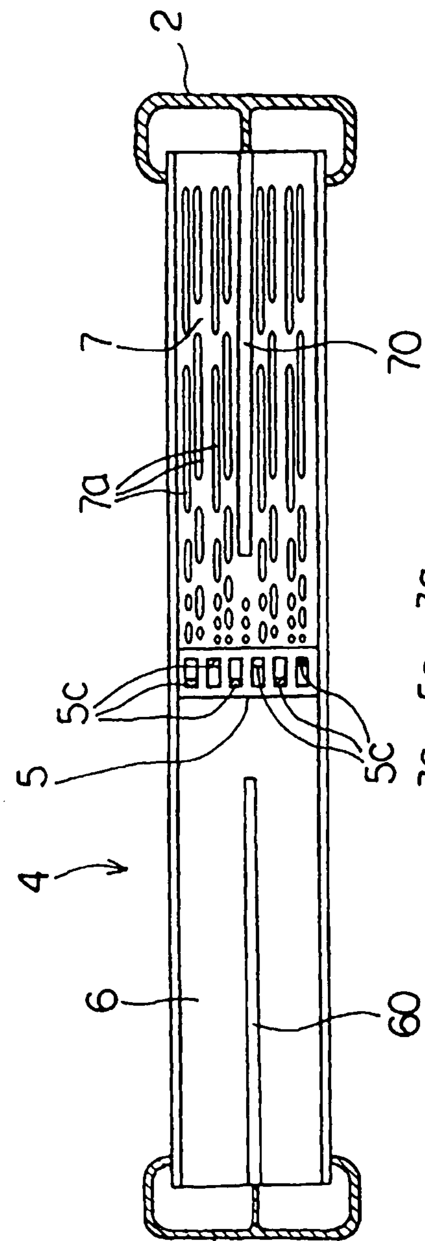


FIG.10



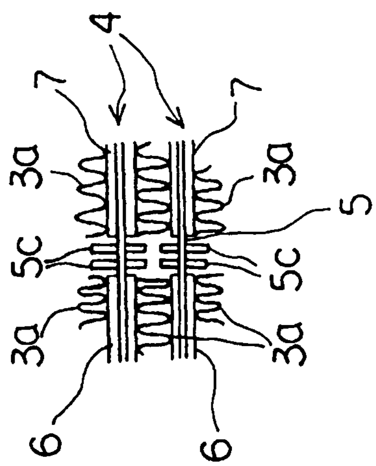


FIG.11

FIG.12

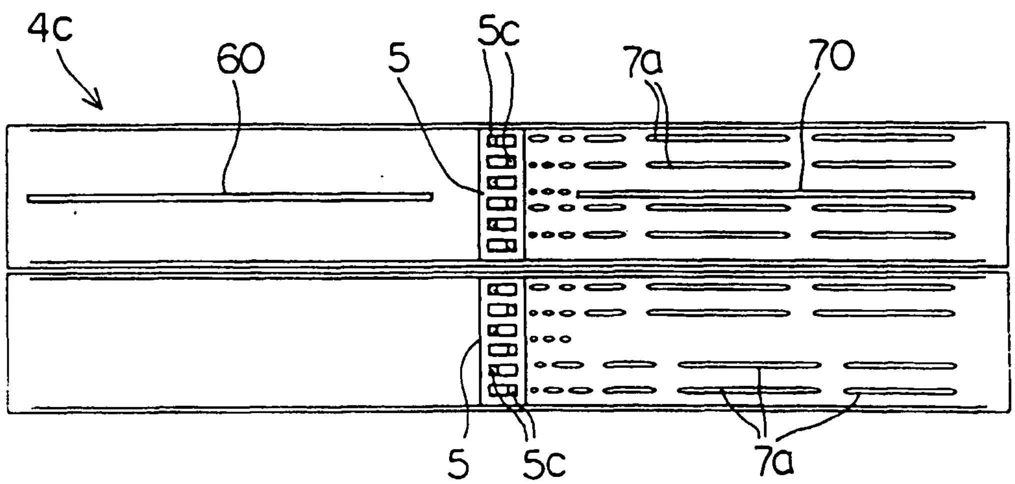


FIG.13

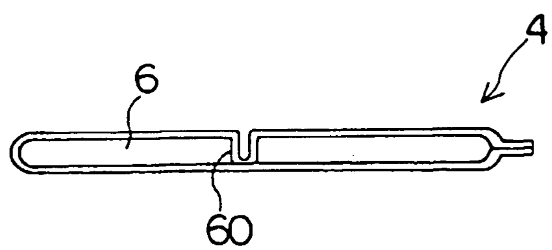


FIG.14

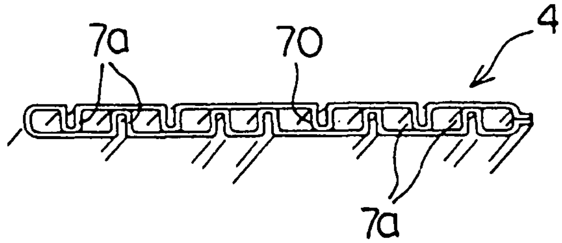


FIG.15

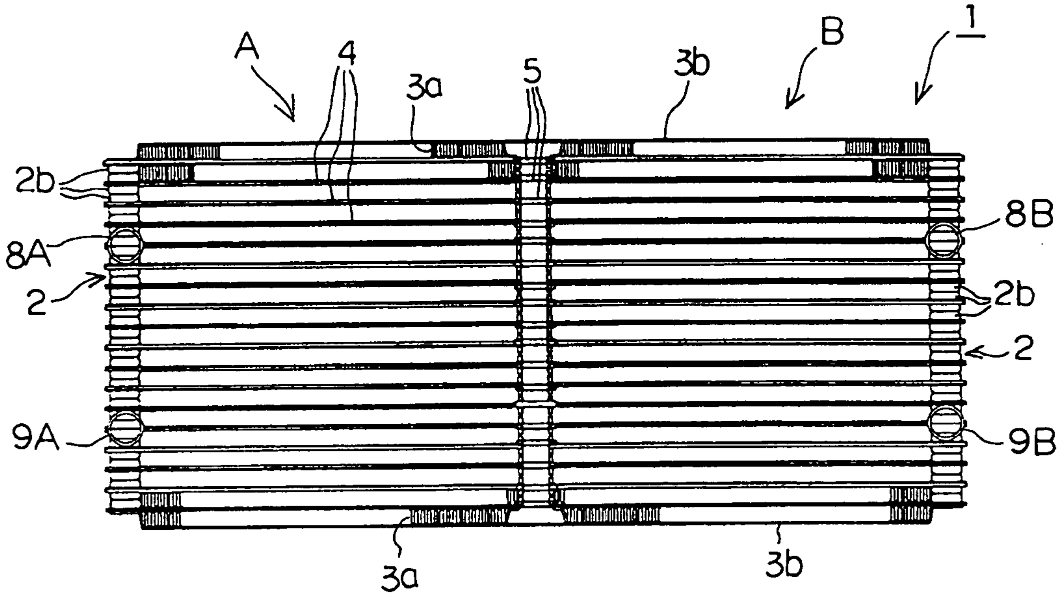


FIG.16

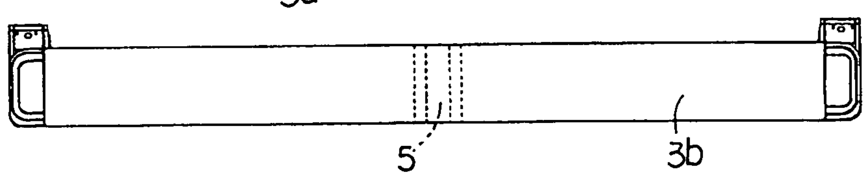


FIG.17

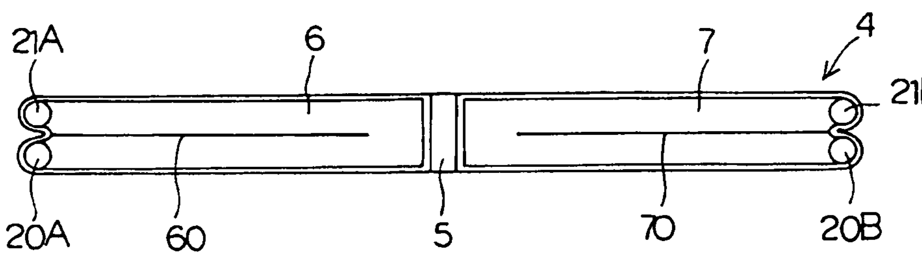


FIG.19

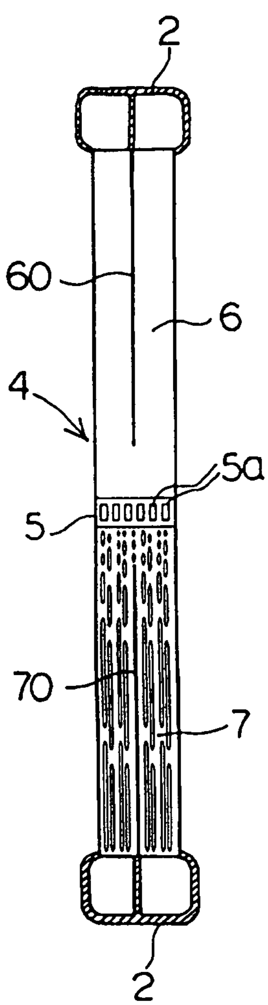


FIG.18

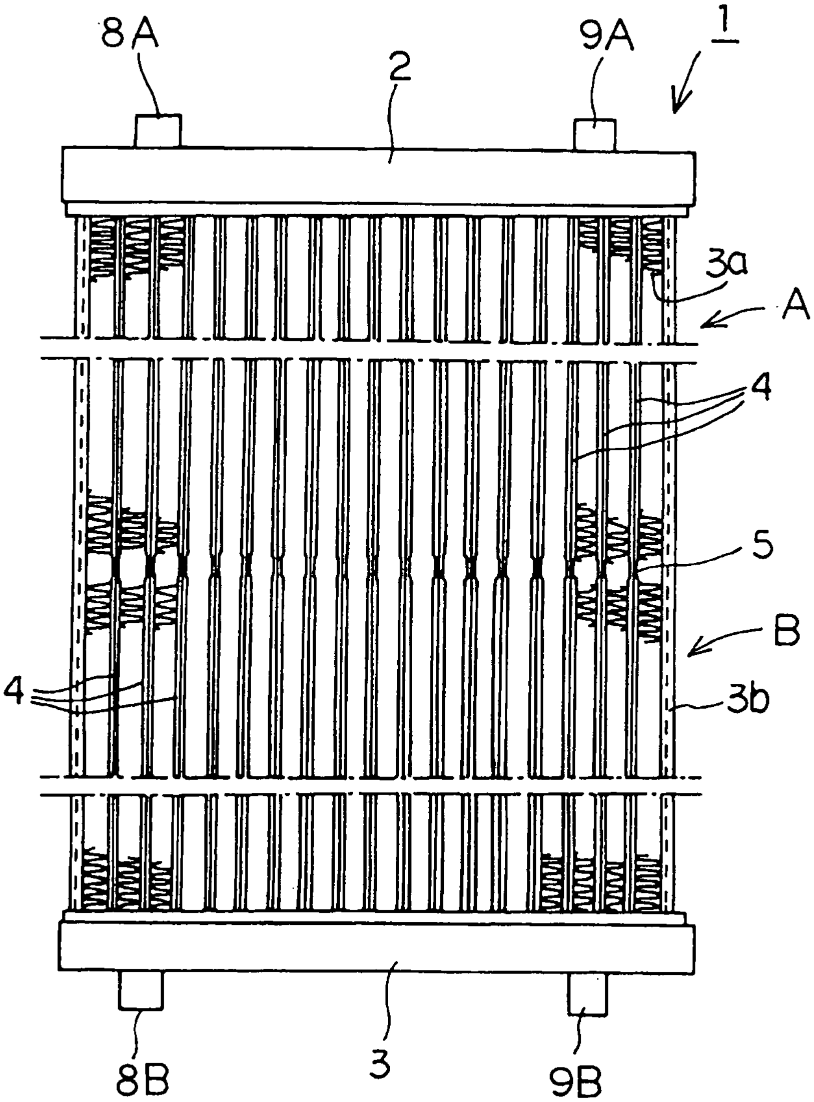


FIG.20

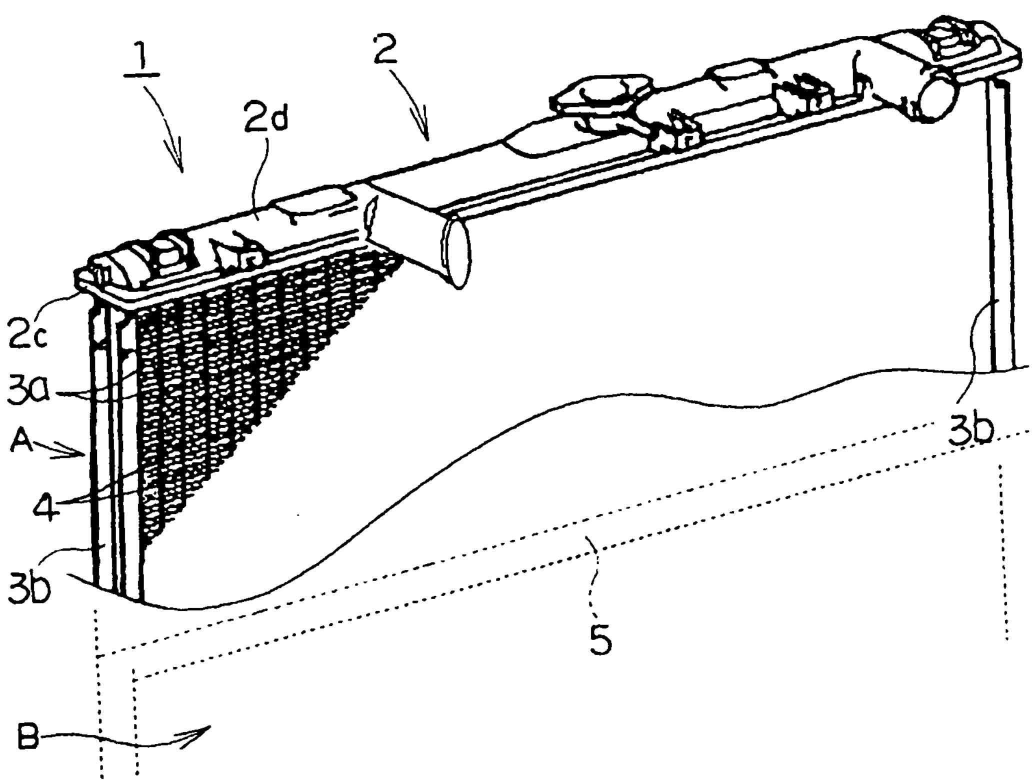


FIG.22

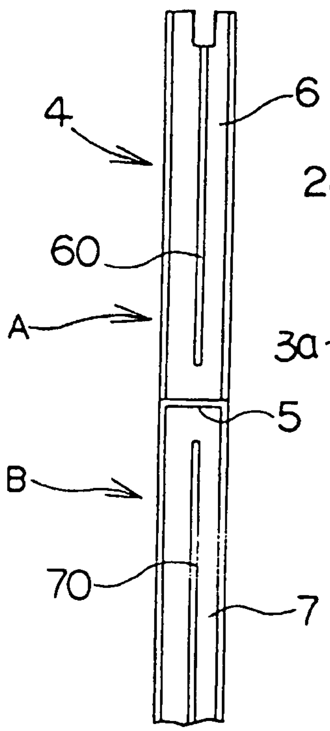


FIG.21

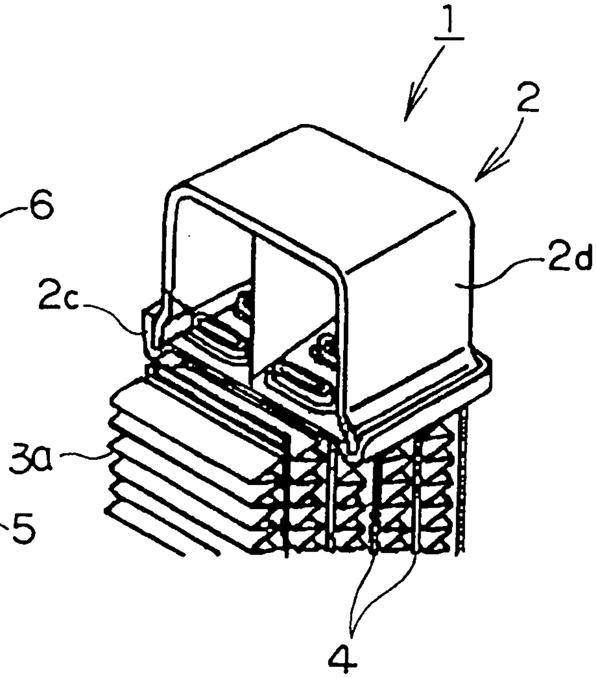


FIG.23

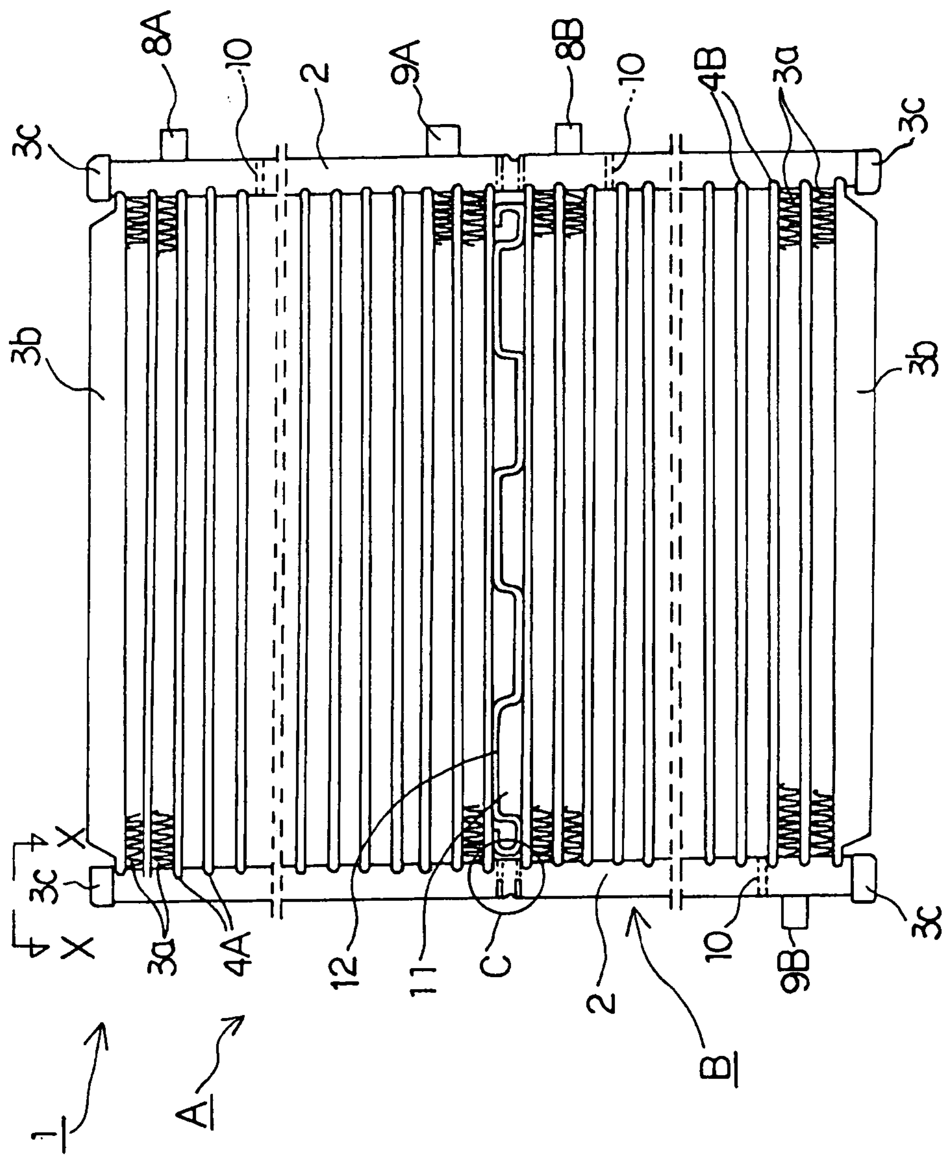


FIG.24

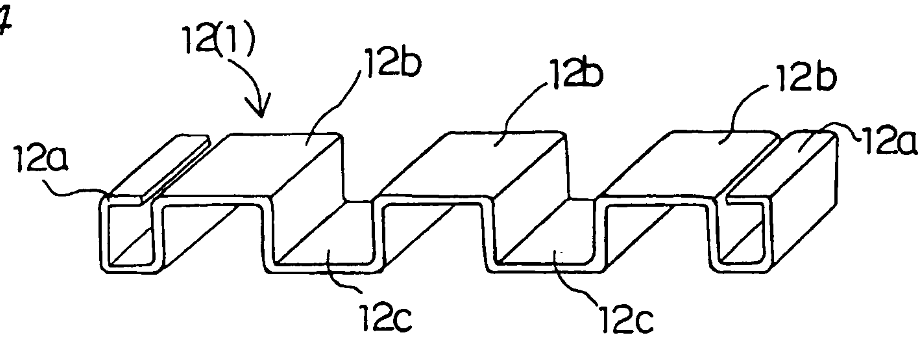


FIG.25

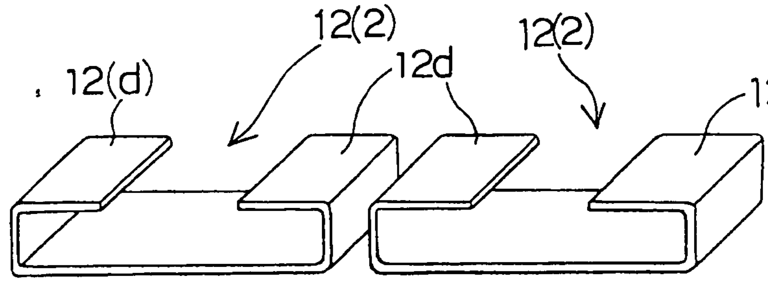


FIG.26

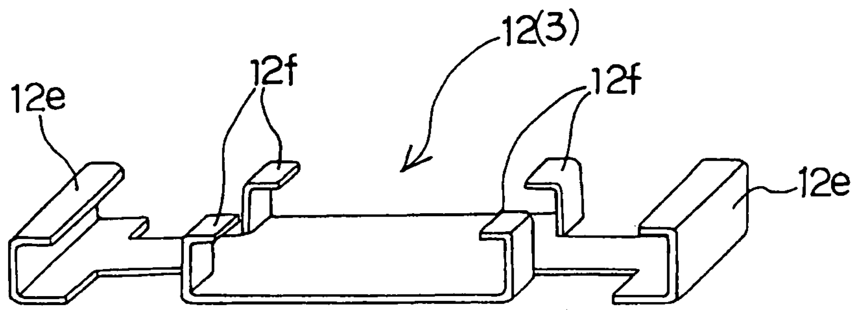


FIG.27

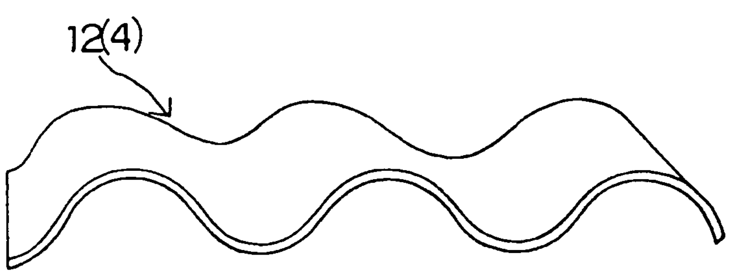


FIG.28

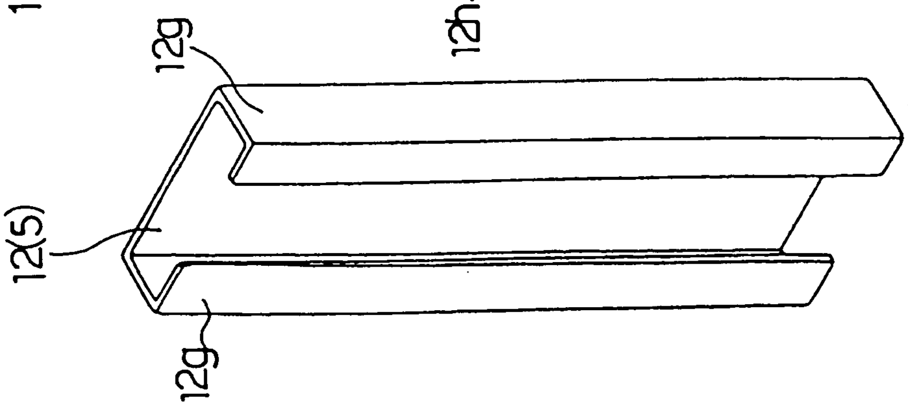


FIG.29

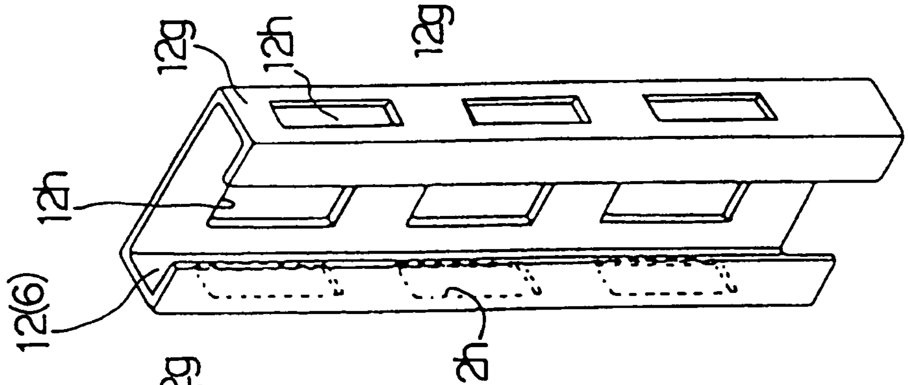


FIG.30

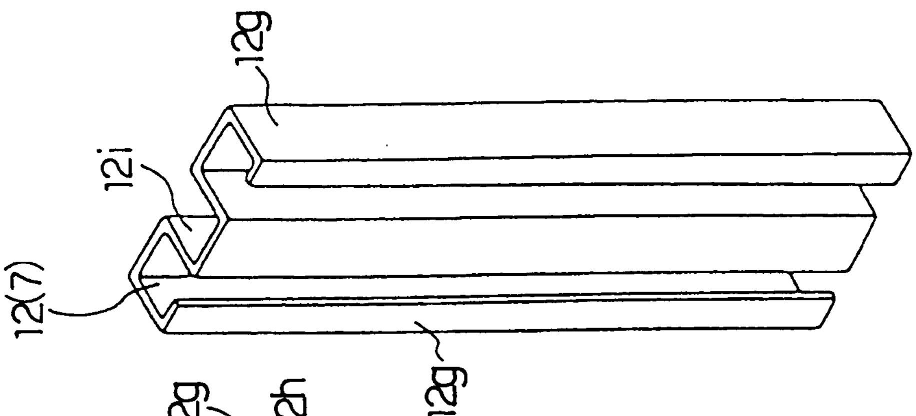


FIG.31

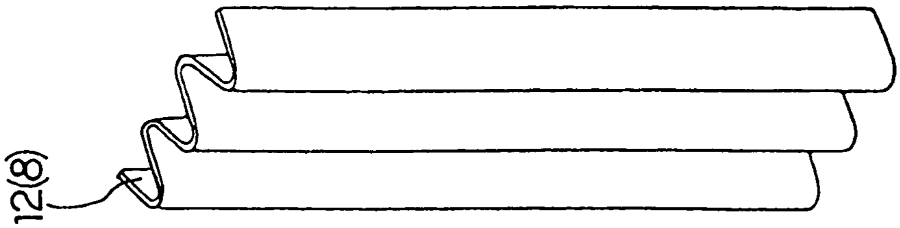


FIG.32

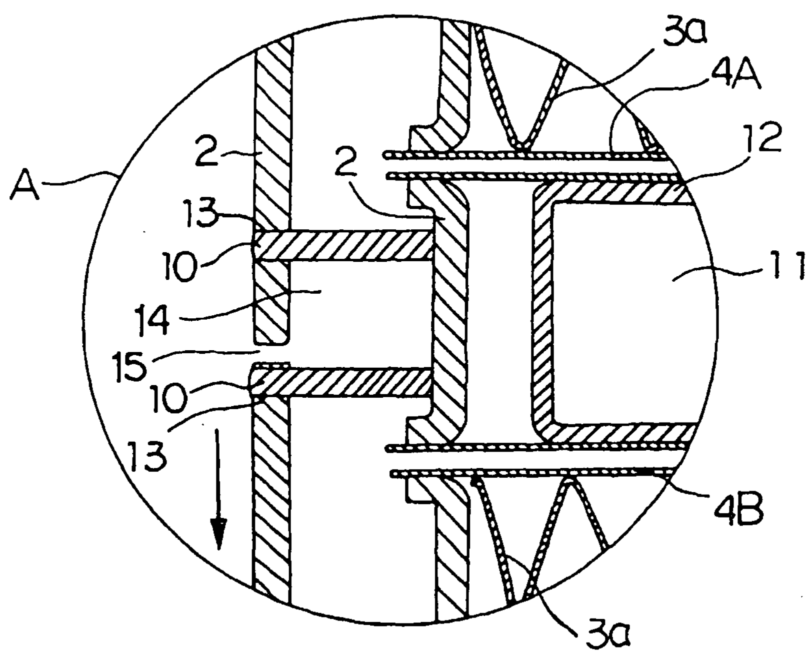


FIG.33

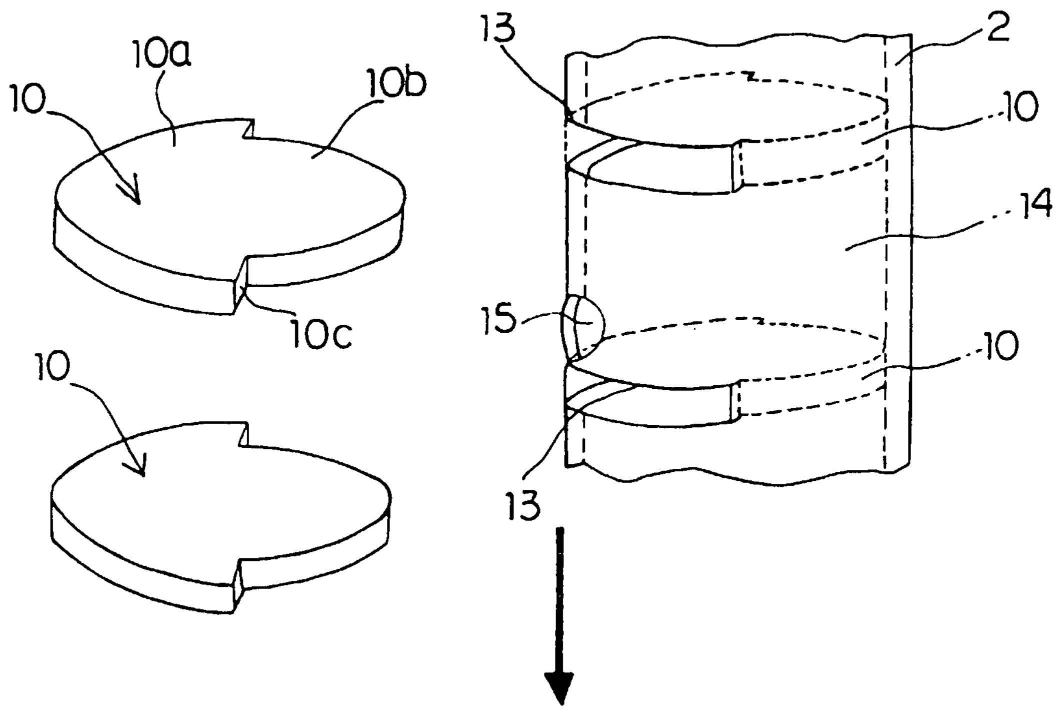


FIG.34

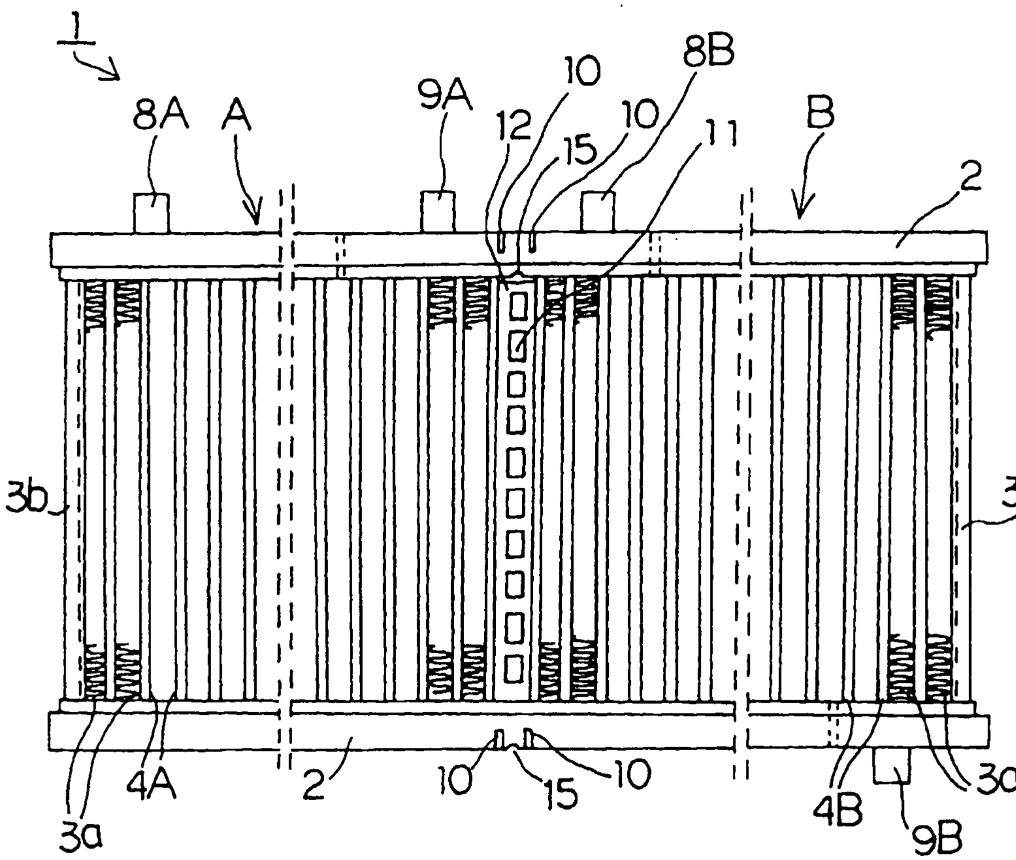


FIG.35

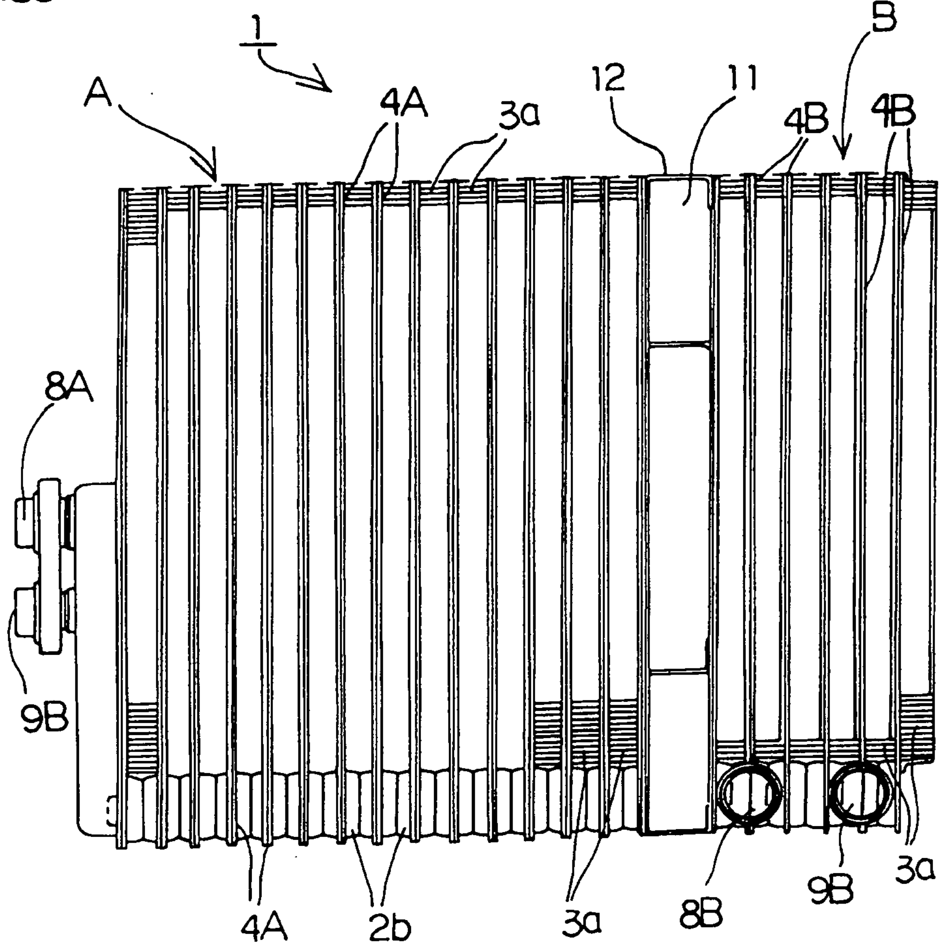


FIG.36

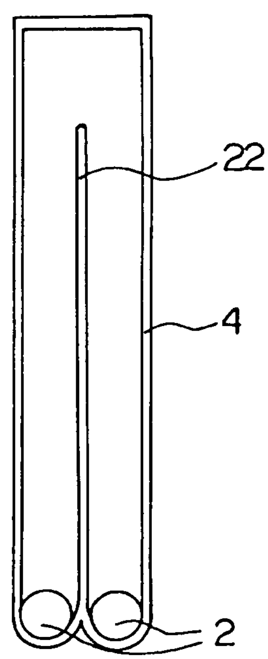


FIG.37

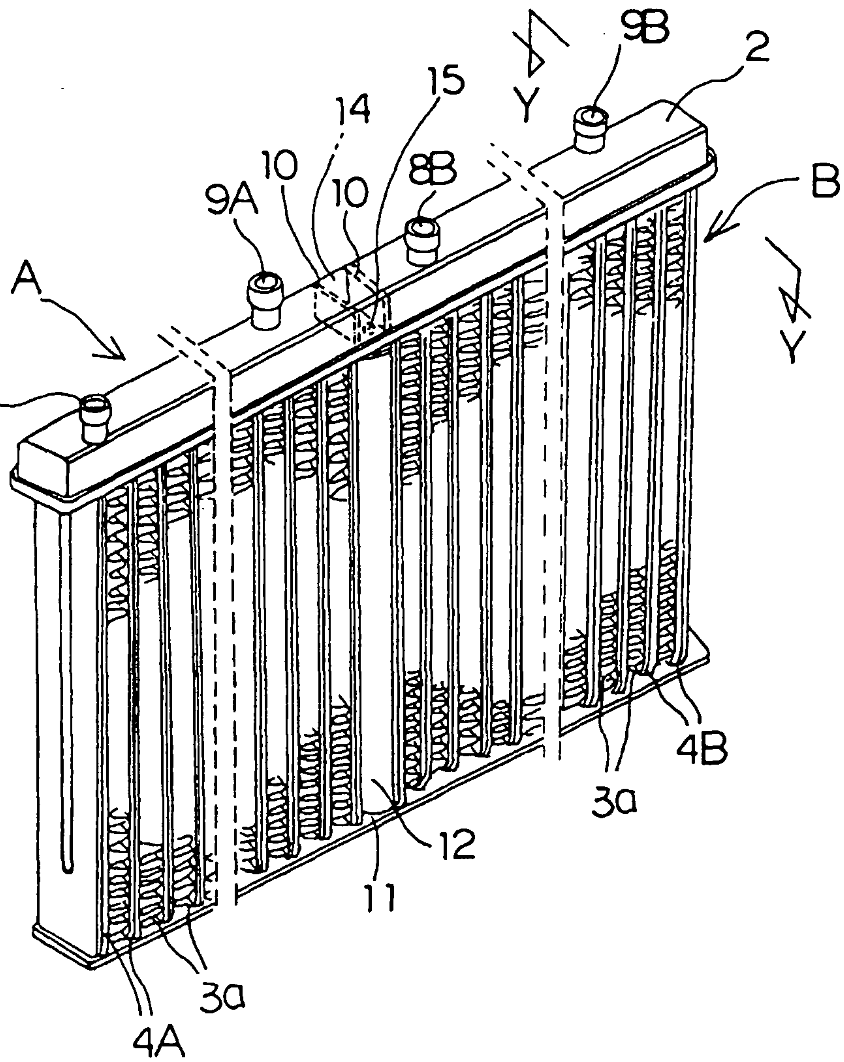


FIG.38

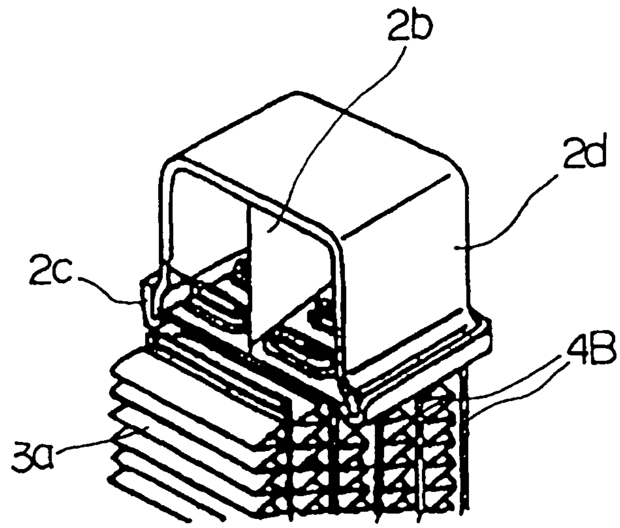


FIG.39

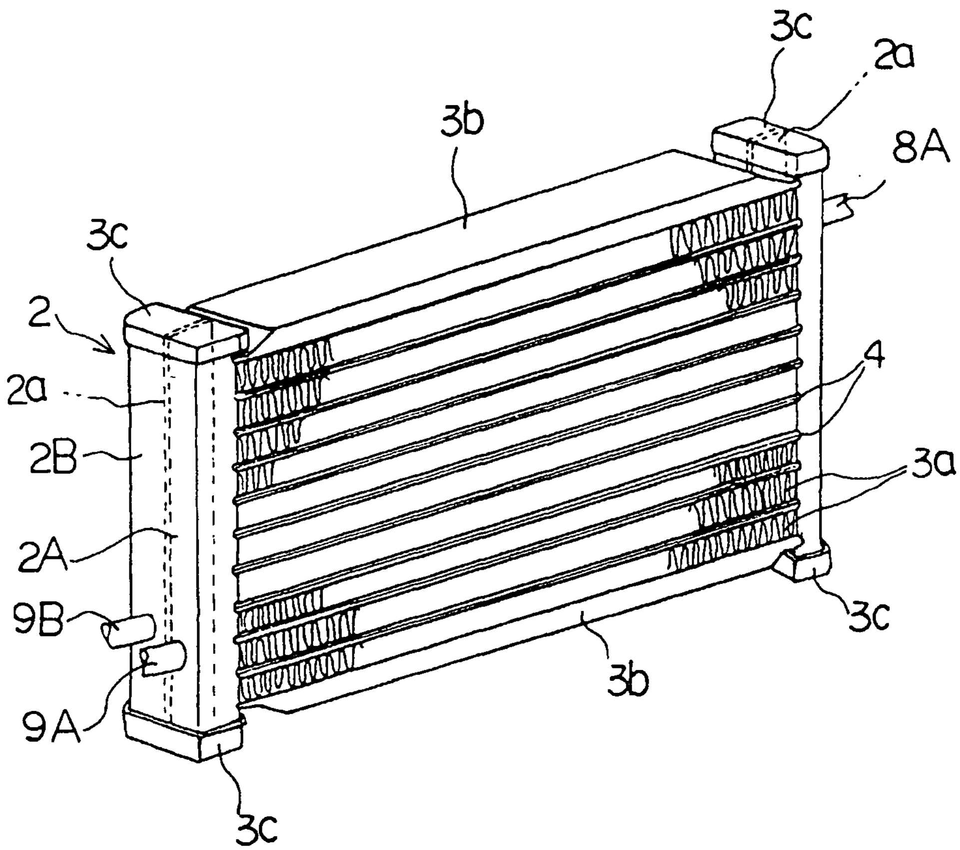
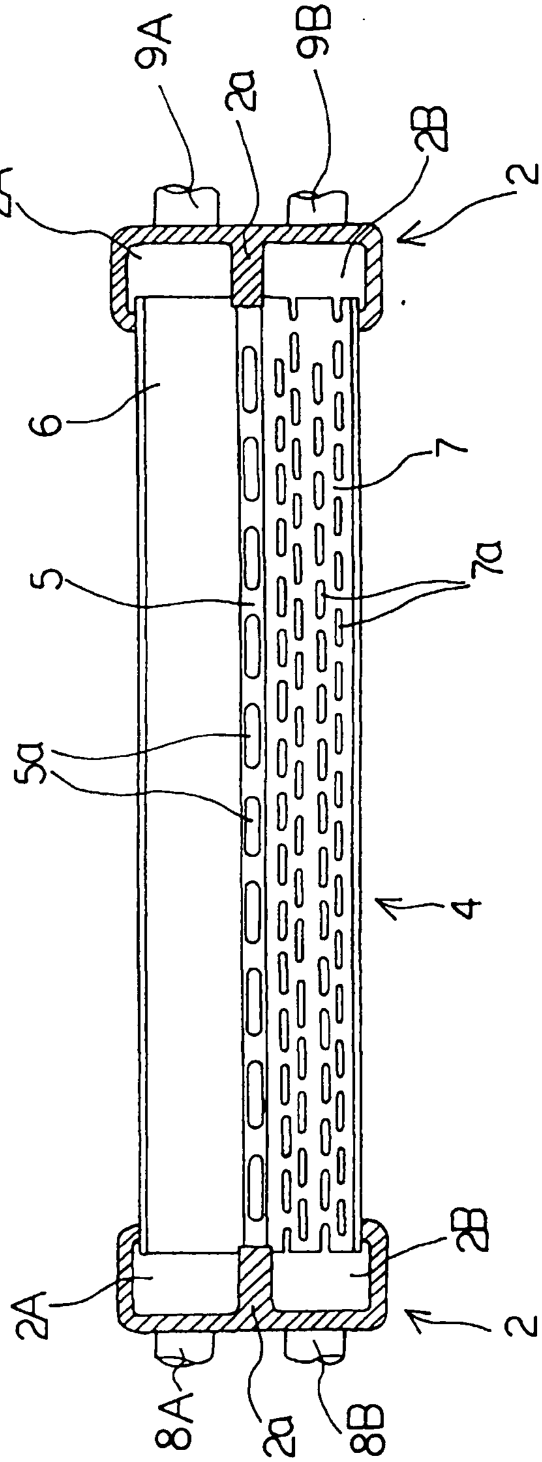


FIG.40



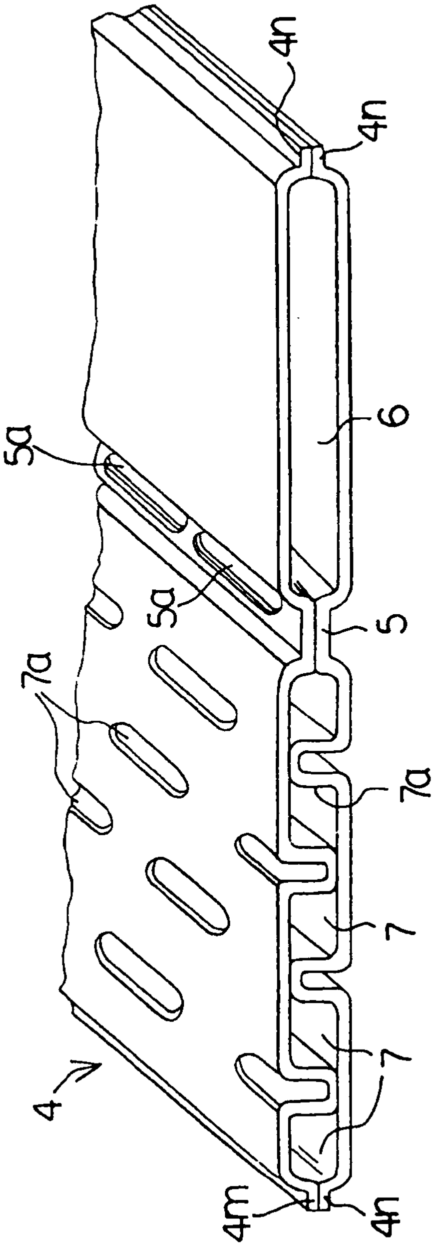


FIG.41

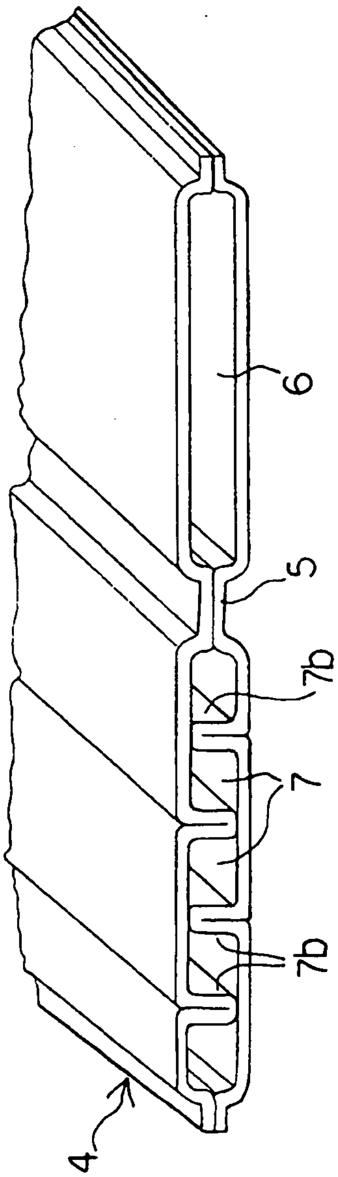


FIG.42

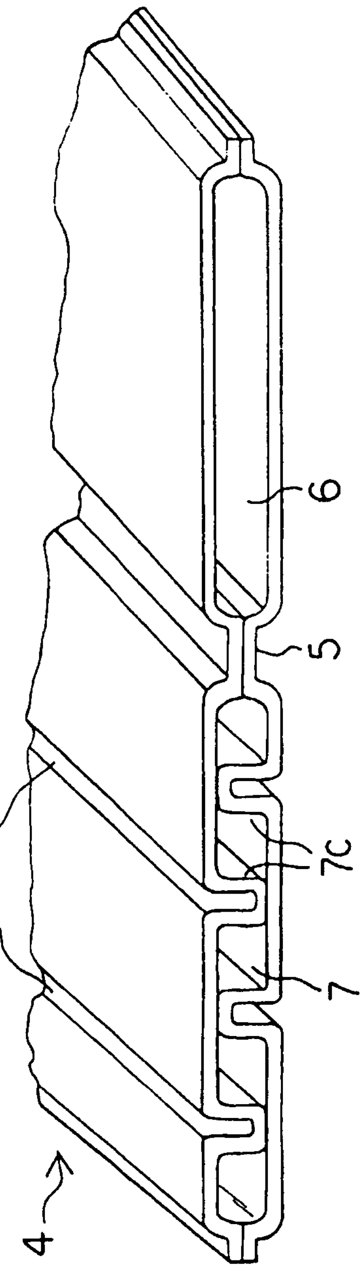


FIG.43

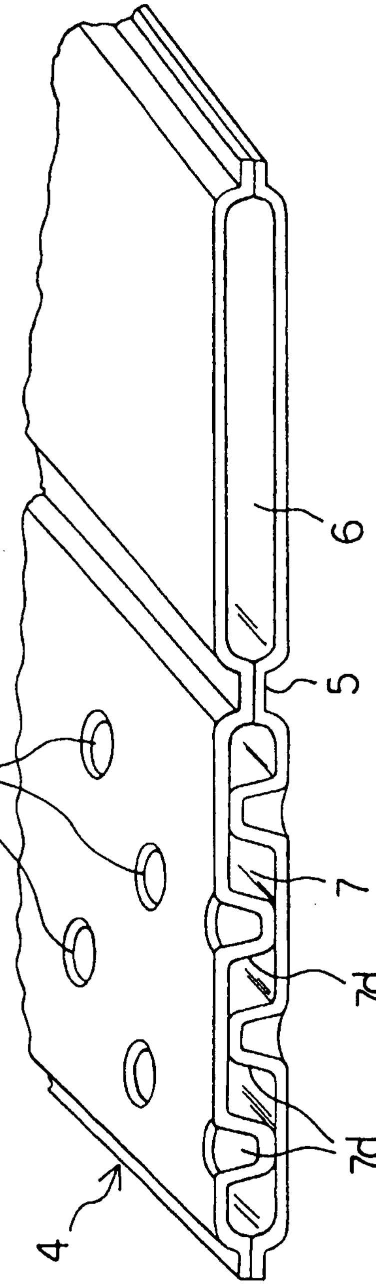


FIG.44

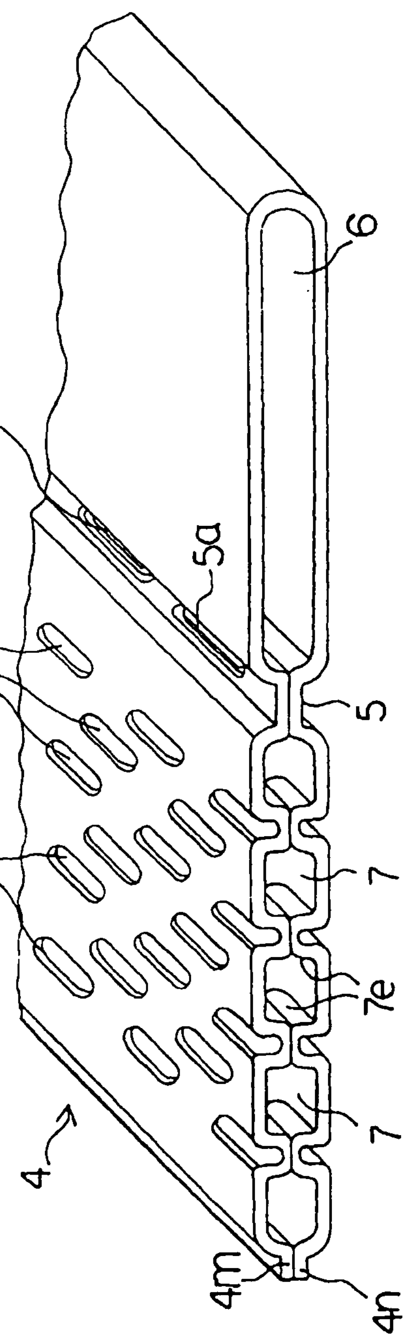


FIG.45

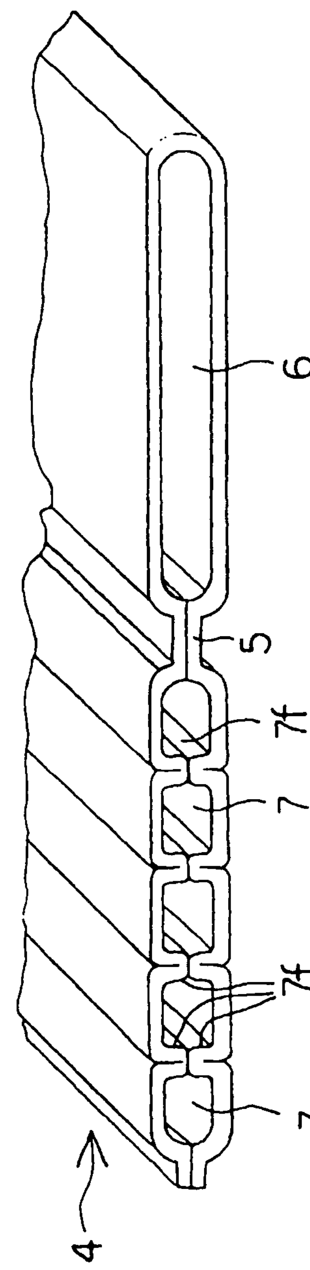


FIG.46

FIG.47

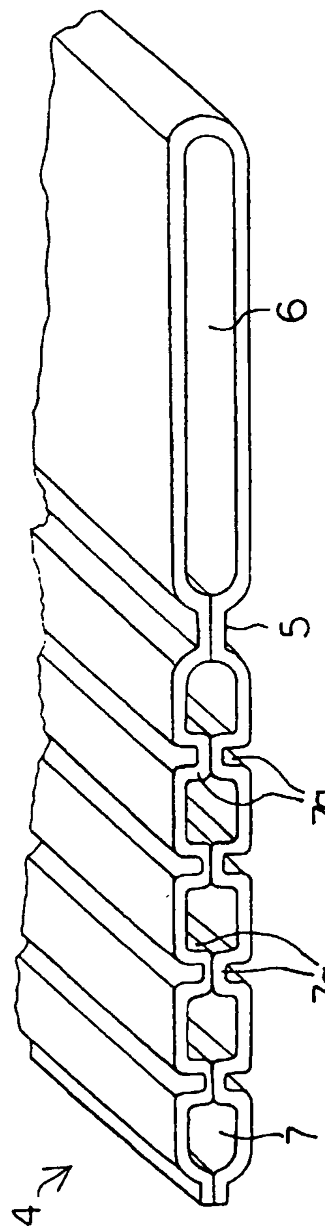
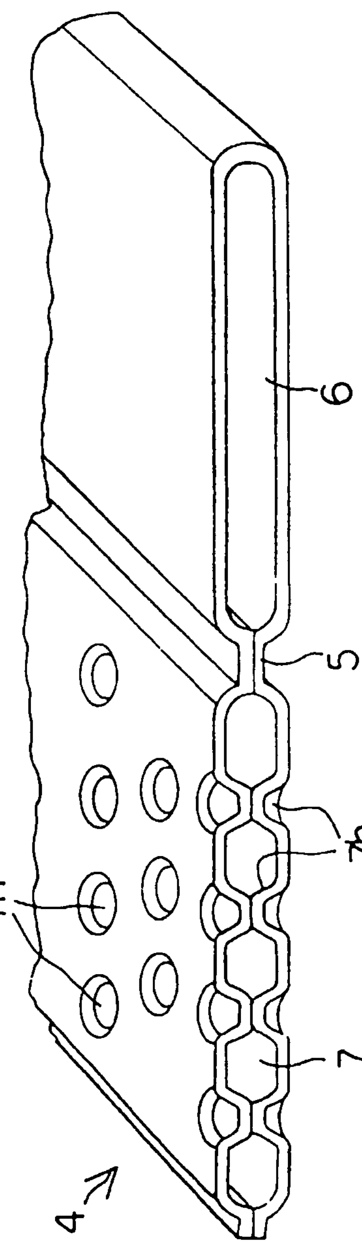


FIG.48



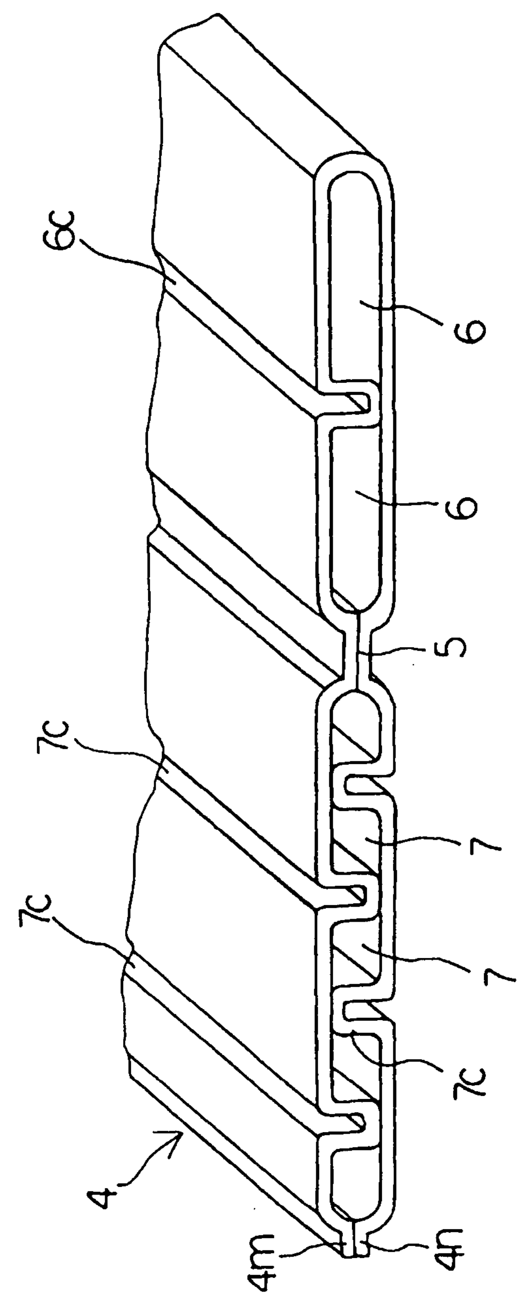


FIG.49

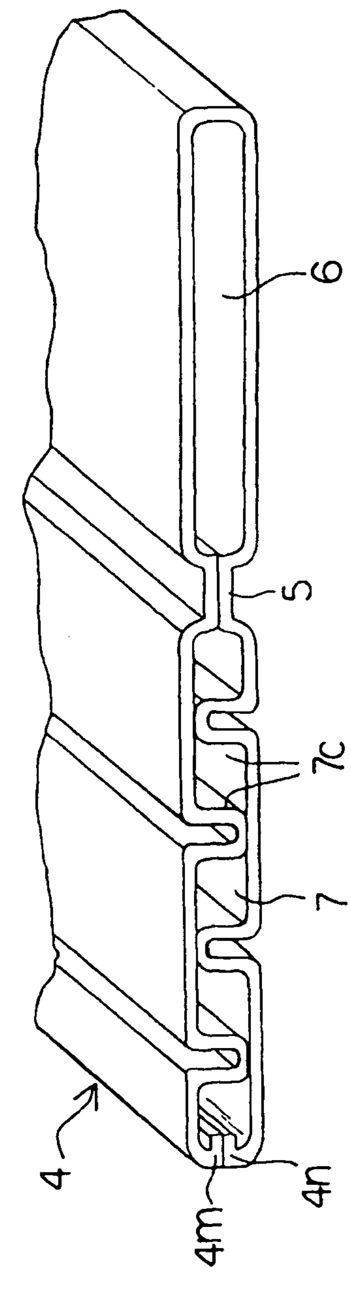


FIG.50

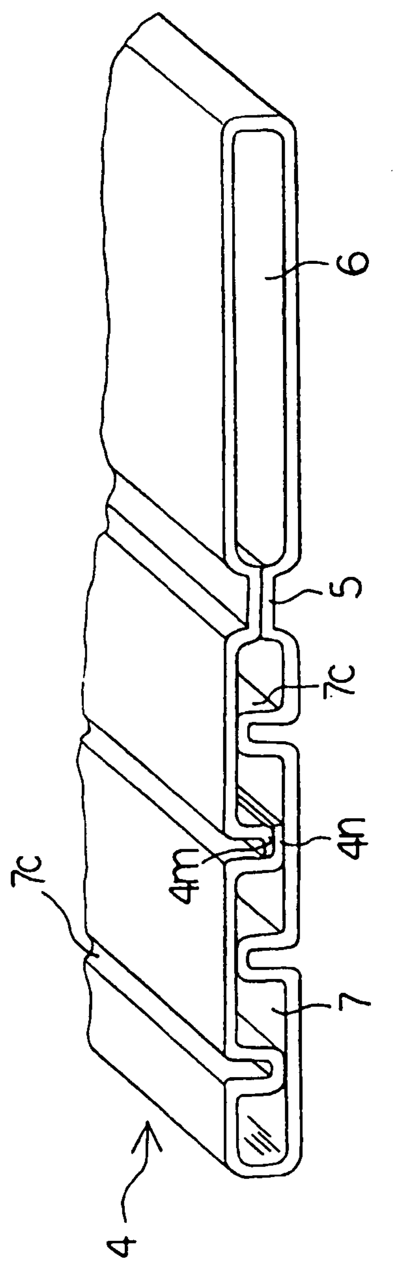


FIG.51

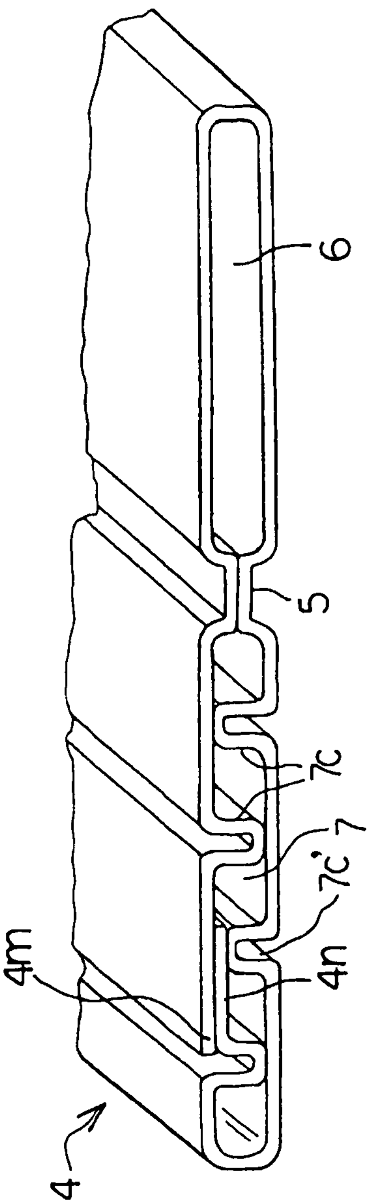


FIG.52

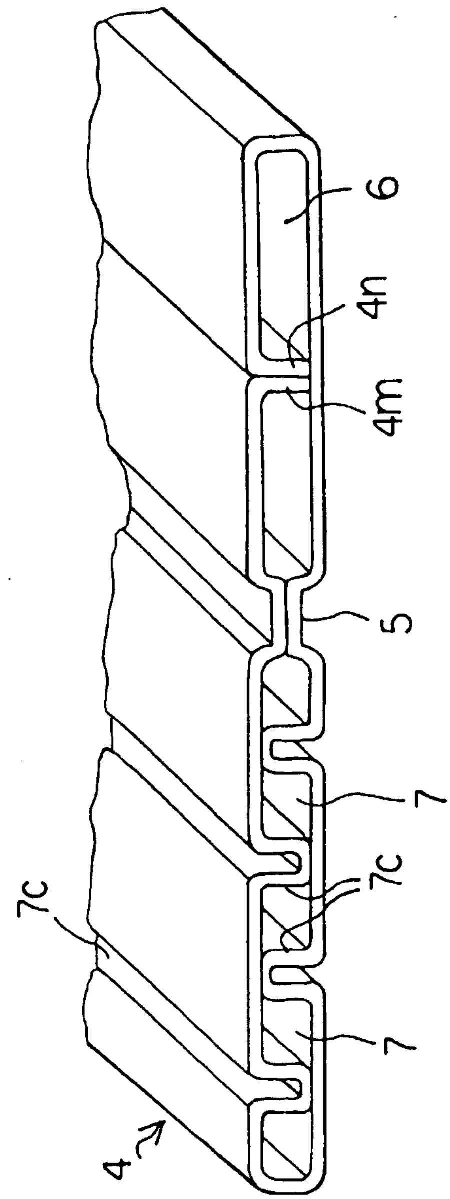


FIG.53

FIG.54

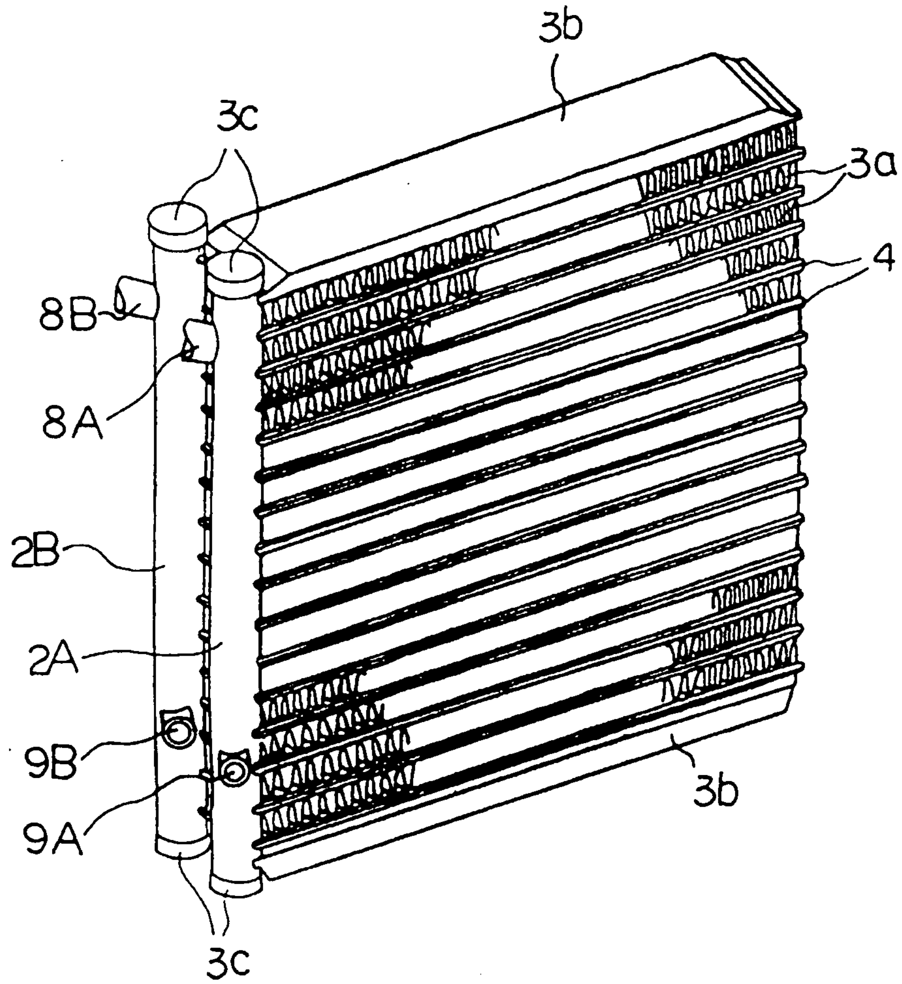


FIG.55

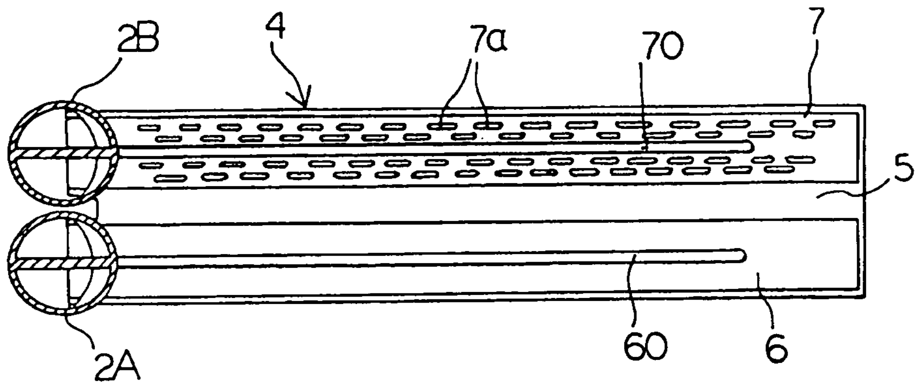


FIG.56

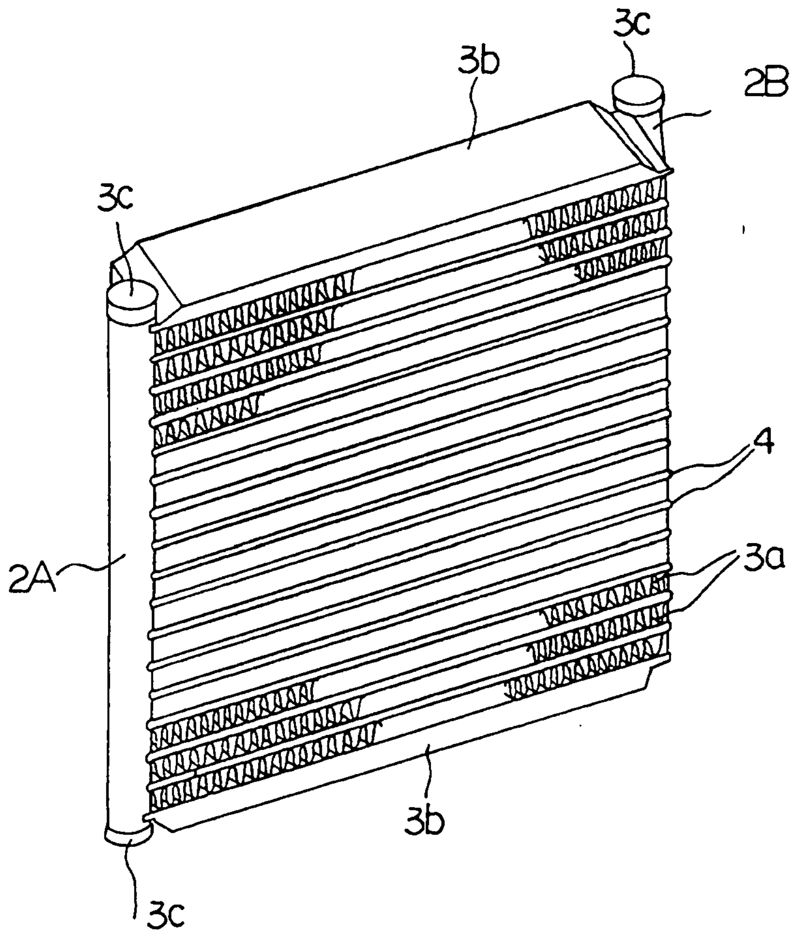
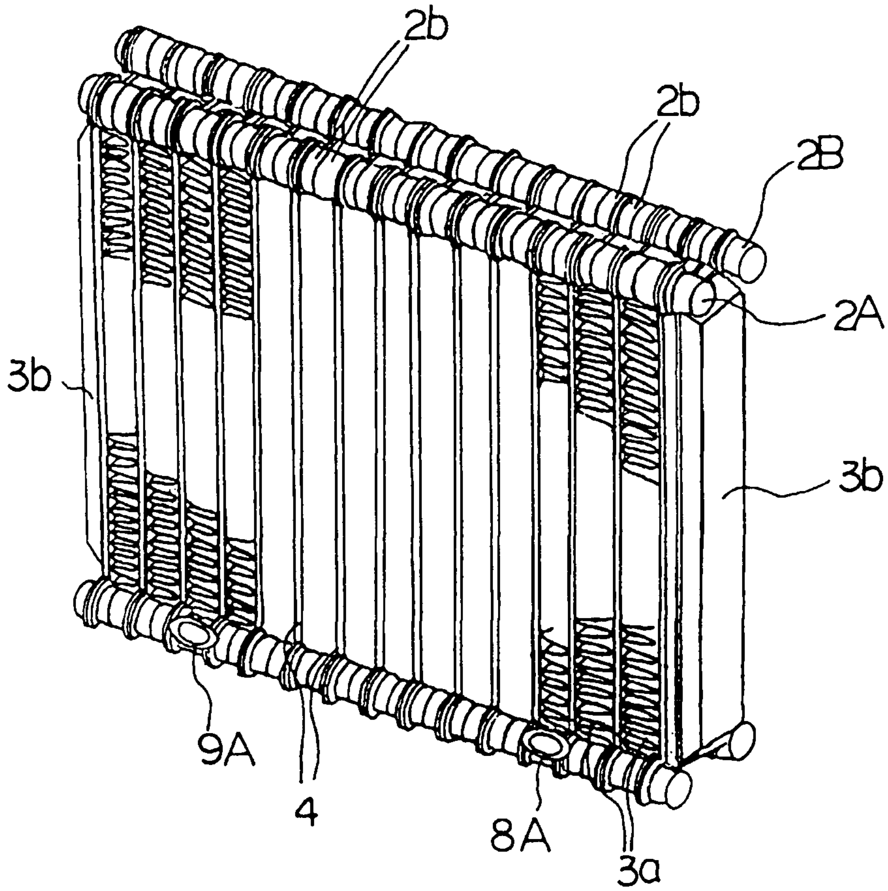


FIG.57



INTERNATIONAL SEARCH REPORT

International application No. PCT/JP97/03010

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^6 F28D1/053, F28F9/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl^6 F28D1/00-13/00, F28F9/00-9/26

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926 - 1997
Kokai Jitsuyo Shinan Koho	1971 - 1997

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 6-45157, Y2 (Showa Aluminium Corp.), November 16, 1994 (16. 11. 94)(Family: none)	1 - 12
A	JP, 64-58991, A (Hisaka Works Ltd.), March 6, 1989 (06. 03. 89)(Family: none)	1 - 12
A	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 28529/1989 (Laid-open No. 122966/1990)(Hitachi, Ltd.), October 9, 1990 (09. 10. 90)(Family: none)	7
A	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 115041/1988 (Laid-open No. 36772/1990)(Sanden Corp.), March 9, 1990 (09. 03. 90)(Family: none)	13 - 18
A	JP, 5-272889, A (Nippondenso Co., Ltd.), October 22, 1993 (22. 10. 93)(Family: none)	15 - 17

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
November 21, 1997 (21. 11. 97)	December 2, 1997 (02. 12. 97)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP97/03010

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 102846/1990 (Laid-open No. 63984/1992)(Sanden Corp.), June 1, 1992 (01. 06. 92)(Family: none)	20 - 29
A	JP, 8-110189, A (Nippondenso Co., Ltd.), April 30, 1996 (30. 04. 96), Page 6, left column, lines 27 to 38 (Family: none)	21
Y	JP, 7-332890, A (Showa Aluminium Corp.), December 22, 1995 (22. 12. 95)(Family: none)	25

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